RO-10-3108 [6,7-Epoxy-1-(4-ethylphenoxy)-3-ethyl-7-methylnonane]

This insect growth regulator (IGR) was incubated in polluted water. After 4 weeks, 78% of the recovered radioactivity was in the form of unaltered IGR. Identification of metabolites was carried out with GC-MS analyses of extracts and comparison with synthesized compounds. Twelve compounds were positively identified as compounds II-XIII (Dorn et al., 1976).

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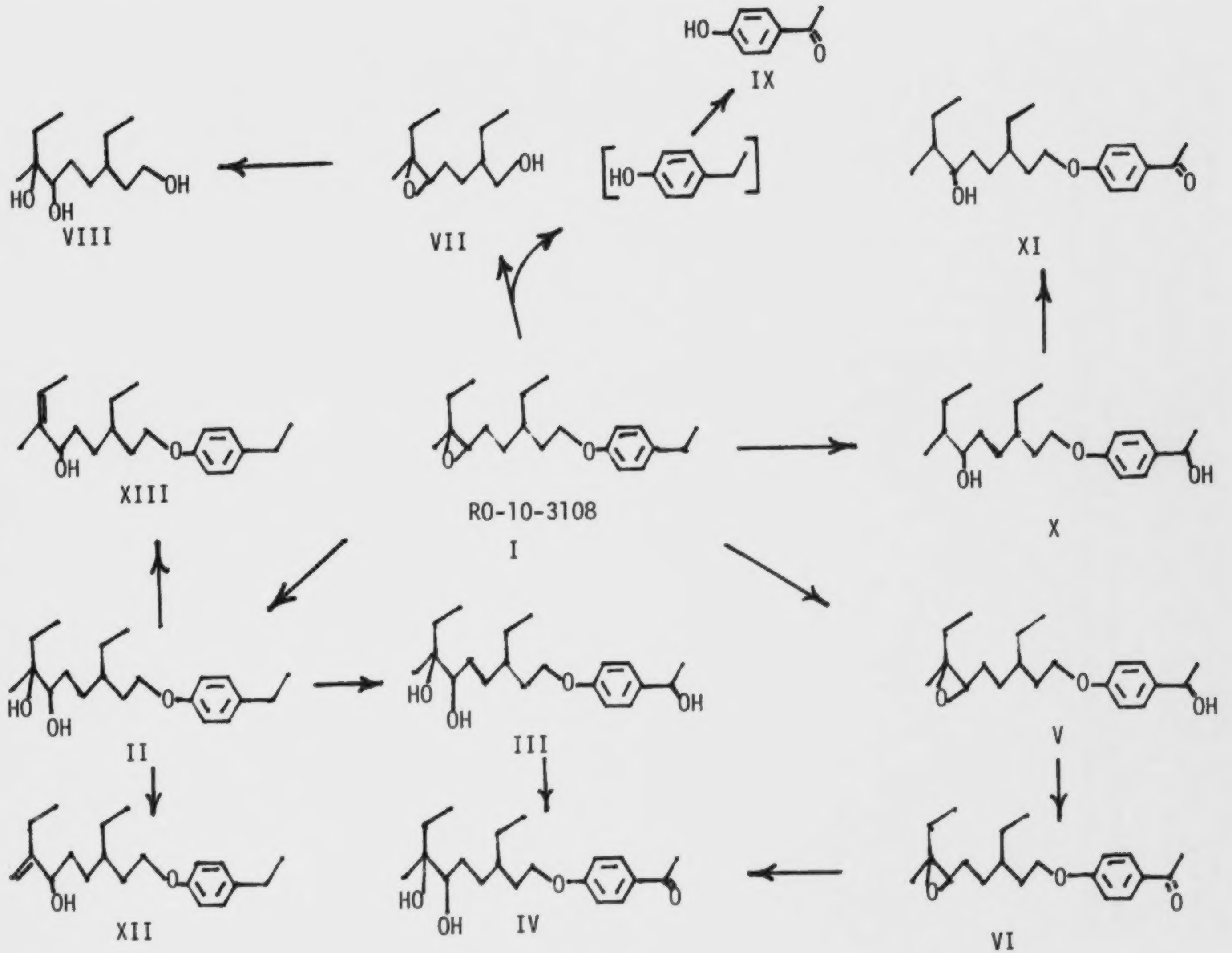

HO
IX
VIII
VII
XI
XIII
RO-10-3108
I
X
II
III
V
XII
IV
VI
HO
OH
O

RO-20-3600 (Bowers' 2b) [(E)-4-(3,7-Dimethyl-6,7-epoxy-2-nonenyloxyl)-1,2-methylenedioxybenzene]

RO-20-3600 was added to a suspension of oxidized hepatic microsomes. Spectral perturbations observed indicated binding to the microsomal cytochrome P_{450} (Mayer and Prough, 1976).

The half-life of this compound in wheat was estimated to be 5 to 8 weeks. In addition to CO_2, the diol was observed (Rowlands, 1976).

KARBUTILATE (Tandex) [N,N-Dimethyl N'-(3-(N-tert-butyl)phenylcarbamate) urea]

In soil and grass, Karbutilate is degraded to the mono-demethyl and di-demethyl analogs. In water, hydrolysis yields N'-(3-hydroxyphenyl)-N,N-dimethylurea (Brandau and Robinson, and Munger and Robinson, unpublished, in Selim et al., 1977).

KEPONE (Chlordecone) [Decachloropentacyclo(5.3.0.$0^{2,6}$.$0^{3,9}$.$0^{4,8}$) decan-5-one]

MIREX [Dodecachlorooctahydropentacyclo(5.3.0.$0^{2,6}$.$0^{3,9}$.$0^{4,8}$)decane]

The stool from patients exposed to massive amounts of kepone (chlordecone) was analyzed. After extraction and cleanup, gas chromatography indicated the presence of a compound which was identified by GC/chemical ionization MS as the alcohol analog (chlordecol) (Blanke et al., 1978).

In studies with workers exposed to kepone, analyses of blood serum indicated an elimination half-life of 63 to 148 days (Adir et al., 1978).

Soil from the vicinity of Hopewell, Va., and mullet from the James River south of Hopewell were collected and analyzed. GLC and MS were used to identify two kepone degradation products as compounds containing 8 and 9 chlorine atoms per molecule. Interpretation of the MS data indicated that soil contained both compounds whereas the mullet contained only the 9-chloro compound (II). The 8-chloro compound was not identified. The data indicated a symmetrically substituted compound (Borsetti and Roach, 1978).

^{14}C-Mirex was given to female Rhesus monkeys. Excretion and tissue distribution was essentially the same when given either p.o. or i.v. Less than 0.6% of the dose appeared in urine and only 7% of the ^{14}C appeared in feces after slightly more than one year. A compound more polar than mirex appeared in the feces (Wiener et al., 1976). Data indicated that the mirex metabolite was a monohydro derivative. GLC, HPLC and MS spectral data confirmed that the metabolite was either the 10-monohydro or 9-monohydro derivative. Some separation of the 10-monohydro derivative and the mirex metabolite indicated that the metabolite was the 9-monohydromirex. The latter, however, has not been synthesized and could not be directly compared (Stein and Pittman, 1977; Stein et al., 1976).

In the presence of reduced hematin, mirex was rapidly reduced in an aqueous medium. Monohydro-, dihydro-, trihydro-, and tetrahydro-derivatives were formed (Holmstead et al., 1976).

Mirex reacted with catalytic amounts of B_{12} in the presence of excess reductant ($NaBH_4$, 1-thioglycerol, 2,3-dimercaptopropanol, or acetoin in alkali) to produce a series of compounds with the composition of $C_{10}Cl_{12-n}H_n$, where n = 1-8. It was shown that successive dechlorination occurred more readily than did the removal of the first chlorine. Some opening of the cage occurred and yielded at least three dehalogenated derivatives of 4,7-methanoindene. Similar studies with kepone yielded dechlorinated derivatives, compounds hydrated and dechlorinated, and some chlorinated indenes (Schrauzer and Katz, 1978).

Mirex underwent slow degradation in the field. Soil samples were taken 12 years after mirex application for fire ant control and 5 years after an aircraft crashed with mirex. About 50% of the original mirex was recovered unchanged. Other degradation products included 8- and 10-monohydro, two dihydro, two trihydro, and one tetrahydro derivatives of mirex in addition to kepone (Carlson et al., 1976a and b).

When mirex was incubated with sewage sludge, 1% of the mirex was metabolized in 2-1/2 months (Andrade and Wheeler, 1973).

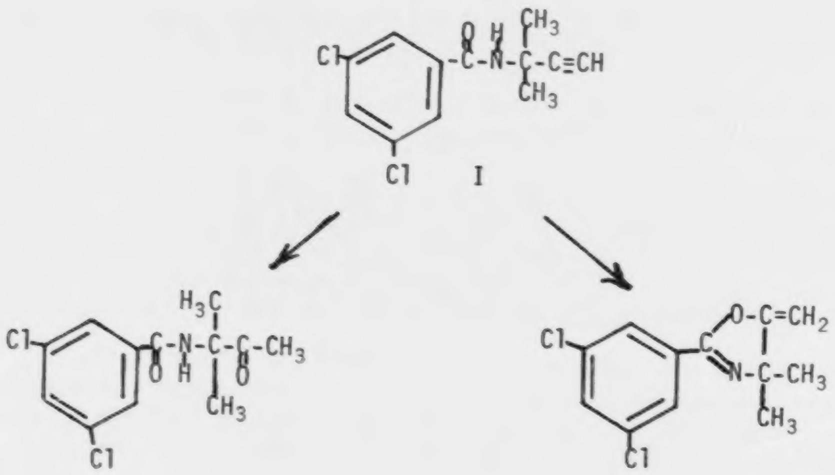
In a simulated marsh system, mirex was concentrated by all animals present. Three photoproducts, 8- and 10-monohydro derivatives and the 2(or 3),8-dihydro derivative, were formed and were present on mirex bait particles. Oysters and one fish species accumulated one of the photoproducts, the 8-monohydro derivative (Cripe and Livingston, 1977).

Photolysis of mirex adsorbed on silica, alumina and clays in water suspension yielded derivatives wherein chlorines have been replaced by hydrogen, kepone hydrate, and derivatives of kepone hydrate in which chlorines have been replaced by hydrogen (Alley and Layton, 1976).

8-Monohydromirex (photomirex) was found in herring gulls, coho salmon, alewives, and smelts in Lake Ontario (Hallett et al., 1978).

KERB (Propyzamide) [N-(1,1-Dimethylprop-2-ynyl)-3,5-dichlorobenzamide]

Degradation of kerb is more rapid in alkaline than in acid soil but this is appreciable only in acidic and strongly alkaline solutions. In acid solution kerb yielded compound (II) whereas in an alkaline medium the oxazoline III arose (Bastide and Coste, 1978).


Cl
Cl
O H CH3
-C-N-C-C≡CH
CH3
H3C
C-N-C-C-CH3
O H O
CH3
O-C=CH2
C
N-C-CH3
CH3

I

II

III

KITAZIN P [S-Benzyl O,O-Diisopropyl phosphorothiolate]

In soil Kitazin P was hydrolyzed and produced O,O-diisopropyl hydrogen phosphorothiolate, which was methylated. Other products observed and identified included benzylthiol, dibenzyl disulfide, benzylsulfonic acid, S-benzyl O-isopropyl hydrogen phosphorothiolate, and sulfate (Tomizawa et al., 1976). When Kitazin P was applied to rice plants, the data indicated formation of some O,O-diisopropyl S-methyl phosphorothiolate, also present as an impurity in Kitazin P (Masuda and Kanazawa, 1973).

Kitazin P was exposed to UV under laboratory conditions. The isomeric thionate, O-benzyl O,O-diisopropyl phosphorothionate, formed and underwent oxidation to the oxon analog, O-benzyl O,O-diisopropyl phosphate. Other products identified included:

O,O,S-triisopropyl phosphorothiolate (XIV)
O,O,O-triisopropyl phosphate (XVI)
O,O-diisopropyl O-benzyl phosphorothionate (XI)
O,O-diisopropyl O-benzyl phosphate (XII)
O,O-diisopropyl phosphonate (III)
O,O-diisopropyl O-methyl phosphate
O,O-diisopropyl O-methyl phosphorothionate
O,O-diisopropyl S-methyl phosphorothiolate
methyl α-toluenesulfonate (IX)
dimethylsulfate
dibenzyl disulfide (VIII)
benzyl isopropyl sulfide (II)
O,O,O-triisopropyl phosphorothionate (XV)
benzaldehyde (V)
benzyl alcohol (IV)
benzoic acid (VI)

(Murai, 1978; Murai and Igawa, 1977)

N-Lauroyl-l-valine

When this peptide was incubated with a rice plant cell preparation or cucumber fruit, CO_2 was detected (Shida et al., 1975a). Incubation of N-lauroyl-l-valine with *Ps. aeruginosa* AJ 2116 yielded lauric acid. GC also gave peaks identical with the retention times of authentic caprylic and capric acids. Some CO_2 was also observed (Shida et al., 1973). N-Lauroyl-l-valine was stable to sunlight and UV but was adsorbed to soil. Lauric acid, capric acid, and l-valine were detected. The fatty acids were metabolized by β-oxidation to CO_2 (Shida et al., 1975b).

LEPTOPHOS (Phosvel, Abar, VCS-506) [*O*-(4-Bromo-2,5-dichlorophenyl) *O*-methyl phenylphosphonothionate]

Leptophos was administered to rats and urine was collected. Hydrolysis readily occurred. The phenoxy portion appeared in the urine as 4-bromo-2,5-dichlorophenol. *O*-Methyl phenylphosphonic acid, *O*-methyl phenylphosphonothioic acid, and phenylphosphonic acid were also found (Whitacre et al., 1976). Other studies gave similar results. Desmethylation yielded CO_2 (Bradway et al., 1977; Hassan et al., 1977).

Female Swiss mice rapidly metabolized orally administered leptophos. The products, excreted mainly in urine, were identified with MS as a 4-bromo-2,5-dichlorophenol free and conjugated (probably the β-glucoside), leptophos oxon, *O*-methyl phenylphosphonothioic acid, *O*-methyl phenylphosphonic acid and phenyl phosphonic acid. A compound that cochromatographed with desmethyl leptophos was also observed (Holmstead et al., 1973).

When applied to cotton plants, leptophos does not penetrate readily. Leptophos oxon was never present in more than trace amounts. Compounds present included *O*-methyl phenylphosphonothionic acid, *O*-methyl phenylphosphonic acid, phenyl phosphonic acid, and 4-bromo-2,5-dichlorophenol (Holmstead et al., 1973).

When applied to burley tobacco plants, leptophos was not metabolized to a large extent within the leaf. Residues consisted of the oxygen analog, 4-bromo-2,5-dichlorophenol, *O*-methylphosphonic acid, and phenylphosphonic acid (Dorough and Whitacre, 1977).

Leptophos penetration in flies was greater in susceptible flies than in resistant flies. Differences in metabolism did not differ largely either qualitatively or quantitatively. Residues of leptophos, in addition to unreacted leptophos, included: leptophos oxon, 4-bromo-2,5-dichlorophenol; desmethyl leptophos oxon; *O*-methyl phenylphosphonothionic acid; *O*-methyl phenylphosphonic acid; and phenylphosphonic acid (Lee and Fukuto, 1976). Residues of leptophos and its metabolites exhibited bioaccumulation factors of 1443 and 48398 in fish and snail, respectively (Sanborn et al., 1977).

When exposed to sunlight, leptophos yielded desbromo leptophos (Velsicol, 1971, in Sanborn et al., 1977).

Leptophos was stable in the acid pH. At neutral pH, ca. 30% of the leptophos was degraded in 4 days. At alkaline pH, leptophos was unstable and followed first-order kinetics.

Leptophos hydrolysis

Temperature	pH	$t_{1/2}$ (h)
25	1	205
	5	222
	7	175
	8	160
	9	104
	10	84
	11	28
30	9	100
40	9	47
50	9	24
60	9	10

(Zayed et al., 1974)

MALATHION [O,O-Dimethyl S-(1,2-dicarbethoxyethyl)phosphorodithioate]

Male Sprague-Dawley rats were dosed by gavage with peanut oil solutions of malathion. Urine was collected and analyses indicated the presence of:

1. malathion α-monocarboxylic acid (MCA);
2. malathion dicarboxylic acid (DCA);
3. dimethyl phosphorothionate (DMTP);
4. dimethyl phosphorodithioate (DMDTP); and
5. dimethyl phosphoric acid (DMP).

Urine from a human poisoning case contained the foregoing compounds and monomethyl phosphate (Bradway and Shafik, 1977).

Hepatic preparations from albino Swiss mice were used to study esterases. Two types of enzymes were observed. Malathion B-esterase is found mainly in microsomes and is similar to non-specific carobxylesterases. It is sensitive to DFP, paraoxon, and EPN oxon and acts at pH 7.4-7.6. Malathion A-esterase has an optimal pH of 8.8 and occurs mainly in the cell sap. This enzyme is insensitive to DPP and other OP's at high concentrations; requires an SH compound for activation; and hydrolyzes the P-S linkage of malathion (Bhagwat and Ramachandran, 1975).

Hepatic enzyme preparations from male mice were used to study dimethyl malathion degradation. The enzyme preparation in the presence of GSH degraded malathion to desmethyl malathion and malathion monoacid. Subsequent nonenzymatic hydrolysis of desmethyl malathion yielded dimethyl thiomalate. It would appear that the enzyme which dealkylates malathion is a GSH transferase rather than A-esterase (Nomeir and Dauterman, 1978).

When ^{32}P-malathion was administered orally to female birds (Gallus domesticus), the material was rapidly metabolized and about 90% was excreted within 24 h via urine (Gupta and Paul, 1976 and 1977). Total ^{32}P was eliminated in the urine by first order kinetics with an average half-life of 5.7 h (Gupta et al., 1977).

Pinfish (Lagodon rhomboides) were exposed to malathion. Whole body analyses showed the presence of malathion mono- and di- carboxylic acids. Malaoxon was not detected (Cook and Moore, 1976).

Studies with the green rice leafhopper (Nephotettix cincticeps) showed that resistant strains exhibit higher carboxylesterase activity (Miyata and Saito, 1976). Resistant smaller brown planthopper (Laodelphax striatellus Fallen) also showed increased carboxylesterase activity (Miyata et al., 1976).

When homogenates of Myzus persicae were incubated with malaoxon, the primary product was dimethyl phosphoric acid. Hydrolysis of the carboxyl ester was not observed (Oppenoorth and Voerman, 1975).

Studies of the metabolism of ^{32}P-malathion were conducted with 600xg supernatant preparations from resistant and susceptible houseflies. Although malathion mono- and di- carboxylic acids were found with resistant and susceptible strains, the resistant strains exhibited much higher levels of both metabolites. Carboxylesterase activity was 30 to 39 times higher in the resistant strains than in susceptible houseflies; malaoxon degrading activity was about 10 times higher. The resistant strains also showed slightly higher levels of dimethyl phosphorothioate and dimethyl phosphorodithioate than was observed in susceptible strains. In one resistant strain, addition of GSH resulted in increased ^{14}C-methyl malathion degradation (Niwa et al., 1977).

When exposed to malathion,, wheat grain exhibited residues mainly in areas of high lipid content, primarily in germ and scutellum and seldom in the starchy endosperm (Rowlands and Bramhall, 1977). Increased moisture content of grain increased degradation of malathion. The rate of degradation was also found to be greater on corn and wheat than on sorghum (Kadoum and LaHue, 1976). When applied to barley, the half-lives for 0.05%, 0.1% and 0.15% malathion concentrations were 1.9, 3.2 and 4 days, respectively (Singh and Soxena, 1976).

Malathion degradation was more rapid in rice than in wheat when stored at 25C. The main products of decomposition were desmethylmalathion and the mono- and di- acids of malathion (Takimoto et al., 1978).

The fungal isolate, Aspergillus oryzae, converted malathion primarily to the β-monocarboxylic acid (97%) and some dicarboxylic acid. In bacterial cultures, about 99% of the malathion was converted to the β-malathion monoacid (Lewis et al., 1975).

Under in vitro conditions, malathion was degraded by Arthrobacter sp. to malathion mono- and di- carboxylic acids, dimethyl phosphorodithioate and dimethyl phosphorothioate (Walker and Stojanovic, 1973). In vivo studies also produced these metabolites in addition to malaoxon and desmethyl malathion. TLC and IR spectroscopy were used to identify the metabolites (Walker and Stojanovic, 1974).

Malathion degradation in sterile seawater increased with increasing salinity. Breakdown products were identified as the mono- and di-carboxylic acids. Bacterial cultures were isolated from salt-marsh environments. Eleven of 15 isolated cultures degraded malathion as a sole carbon source. All isolates degraded malathion when a carbon source was added. All isolates produced 10 metabolites on TLC. Four compounds were identified as the two carboxylic acids, malathion and desmethyl malathion. Other compounds not identified were believed to be phosphorus-containing metabolites. Some CO_2 was also produced from the methyl groups (Bourquin, 1977).

A heterogeneous bacteria population, capable of degrading malathion, was isolated from river water. Incubation with malathion produced β-malathion monoacid primarily. About 1% of the malathion was converted to the di-acid. Dimethyl phosphorodithioic acid and diethyl maleate were also observed. The di-acid identity was confirmed by GC of the methylated material. Identity of the other compounds was confirmed by MS (Paris and Lewis, 1974a and b; Paris et al., 1975).

An enzyme was obtained from Chehalis clay loam. Incubation with malathion produced the monoacid (Getzin and Rosefield, 1971).

Malathion breakdown in soil was found to be a combination of biological and nonbiological hydrolysis. Breakdown half-life in clay plus organic matter was one day (Gibson and Burns, 1977). Studies with malathion on attapulgite indicated that degradation on the clay involved two stages, one short-lived (a few days) and a longer one (Valange, 1975). In other studies, malathion degradation in soil was increased by addition of suitable co-substrates such as n-heptadecane or 1-heptadecene (Merkel and Perry, 1977). In a basic soil, malaoxon half-life was 3 days whereas in acidic soil it was about 7 days. Microbial activity exerted only a minor effect on the half-life of malaoxon. This may be the result of the observed biocidal effect of malaoxon on soil microorganisms (Paschal and Neville, 1976). Four microorganisms, isolated from a sediment enriched with malathion, degraded malathion. One organism produced the malathion monoacid; a second produced the dicarboxylic acid through the monoacid as an intermediate (Walker, 1976).

pH	T(C)	T	Starting Compound	Products
2.5	87		Malathion	α- and β-malathion monoacid
2.5	87		Malathion diacid	Dimethyl phosphorothionic acid and thiosuccinic acid.
8.0	27	36h	Malathion	α- and β-malathion monoacid, diethyl fumarate, dimethyl phosphorodithioic acid
8.0	40	1h		
8.0	0	40d		
10.39	27		Malathion monoacid	Malathion diacid, diethyl fumarate, ethyl hydrogen fumarate and dimethyl phosphorodithioic acid
8.0	27	26d		
11.3	27		Malathion diacid	Dimethyl phosphorothionic acid and thiomalic acid
9.0	27	1y		

Acid hydrolysis of malathion was slower than basic hydrolysis by five orders of magnitude (Wolfe et al., 1974 and 1977).

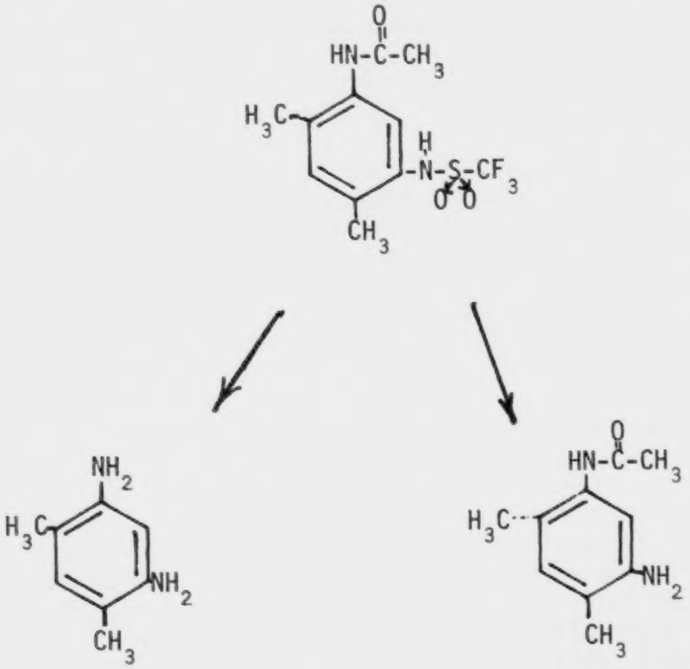
MEBENIL (BAS 305F, OTA) [*o*-Toluanilide]

Mebenil was administered by stomach tube to rats, rabbits and guinea-pigs and as a suspension in corn oil to young rats and gerbils. Metabolites excreted included large amounts of 4-hydroxy-*o*-toluanilide and small amounts of the 2'-HO isomer. Enzymatic hydrolysis showed the presence of the glucuronide of the 4'-hydroxy analog and some 2'-glucuronide. Sulfates were also observed. Several other compounds were observed but not identified (Warrander and Waring, 1977).

A *Nocardia* sp., capable of using acid anilides as a sole source of carbon, was isolated from soil. Degradation was initiated by amide hydrolysis. This was followed by oxidation of the aniline moiety via pyrocatechol and the β-ketoadipate pathway. The acid moiety accumulated in the incubation medium (Bachofer, 1976).

MEFLUIDIDE (MBR 12325, Embark) [*N*-[(2,4-Dimethyl-5-trifluoromethylsulfonylamino)phenyl]acetamide]

^{14}C-Mefluidide was applied to soybean and common cocklebur. Soybeans formed 4,6-diamino-*m*-xylene, 6-acetamido-4-amino-*m*-xylene, and conjugates (Bloomberg and Wax, 1978).


HN-C-CH3
O
H3C
H
-N-S-CF3
O O
CH3
NH2
H3C
NH2
CH3
HN-C-CH3
O
H3C
NH2
CH3

MEOBAL [*N*-Methyl 3,4-xylylcarbamate]

When meobal was applied to bean plants (*Phaseolus vulgaris*), meobal was metabolized to *N*- and 4-hydroxymethyl meobal plus unidentified compounds (Ohkawa *et* al., 1974b).

MERCURY

After administration of methoxyethylmercury chloride (MEMC) to mice, inorganic mercury was observed in gastric contents. Mercury in feces was probably as mercuric sulfide (Yonaha et al., 1975).

When rats were administered methoxymethyl mercury acetate as a single oral dose, mercury in the metallothionein fraction increased with time (Helleberg and Gyrd-Hansen, 1976).

The whole-body half-life of methylmercury in cats, after a single oral dose, was 117.7 ± 1.4 days (Hollins et al., 1975).

In female albino rats administered methylmercury chloride, the $t_{1/2}$ for the whole body was 34 days. Brain exhibited a $t_{1/2}$ = 26 days (Magos and Butler, 1976). Transport of methylmercury from liver to bile probably occurred as a glutathione complex (Refsvik, 1978). Within the liver of female Wistar rats injected with methylmercury chloride, the predominant small molecular weight mercury compound within the liver cytosol was methylmercury glutathione (Omata et al., 1978).

The bacterial flora of the rat caecum metabolized methylmercuric chloride *in vitro* to a volatile product believed to be metallic mercury. In the small intestine, prior synthesis of hydrogen sulfide was required for metabolism of methylmercuric ion to a volatile sulfur derivative (Rowland et al., 1977 and 1978). *In vitro* studies showed that methylmercury chloride was converted in the presence of H_2S to bis(methylmercury)sulfide which then decomposed slowly to dimethylmercury and β-HgS. Dimethylmercury was evolved into the gaseous phase (Craig and Bartlett, 1978; Deacon, 1978).

Following methylmercury exposure, tissues of rainbow trout (*Salmo gairdneri*) showed selective binding of mercury. Gill and kidney tissue metallothionein bound inorganic mercury whereas methylmercury was predominant with liver metallothionein (Olson et al., 1978). Other studies indicated that in salmon (*Oncorhynchus nerka*), mercuric and methylmercuric ions were sequestered by lipoproteins of fish serum under physiological conditions (Reichert and Malins, 1974).

Studies with mink fed methylmercury contaminated fish indicated that some demethylation did occur (Jernelov et al., 1976).

A single oral dose of methylmercury nitrate was administered to a squirrel monkey. Excretion was slow and the whole body burden biological half-time was 134 ± 2.7 days. The slow loss was occasioned by the loss of methylmercury into fur, which contained half the total body burden by the 85th day. Some methylmercury, transformed to inorganic mercuric compounds, was observed in liver, kidney, bile and brain (Berlin et al., 1975).

Methylmercury dicyandiamide was inactivated by Penicillium notatum and other soil organisms but no products were identified (Munnecke and Moore, 1975).

γ-Globulin degraded phenylmercury to Hg^{2+} but the methyl- and methoxyethyl mercury compounds were not degraded. All three compounds were degraded to some extent by ascorbate and by soluble proteins. Degradation by ascorbate also required Cu^{2+} (Gage, 1975).

When E. coli was exposed to phenylmercuric borate (PHB), PHB rapidly incorporated into the cells. PHB appeared to become fixed to ribosomal proteins of the cytoplasmic membrane (Cortat, 1978).

Studies were conducted with Chlorella cultures having an induced resistance to mercuric chloride and phenylmercuric acetate (PMA). These cultures exhibited elevated levels of an enzyme system that reduced these compounds to Hg^0. These cells volatilized more mercury into the air than did nonresistant cultures. The enzyme system exhibited a sulfhydryl requirement. The system seemed to be a general one since it was able to reduce a number of metallic ions (DeFilippis, 1978).

Methylation of mercury was greater in sediments under reducing conditions than under oxidative conditions. More methylmercury was produced from phenylmercuric acetate than from a similar amount of mercuric chloride (Jacobs, 1974).

In vitro studies showed that thiols reacted with phenylmercury compounds and cleaved phenyl groups. This cleavage proceeded more rapidly in polar solvents than in nonpolar solvents.

$$Ph_2Hg + PhSH \rightarrow Ph\text{-}S\text{-}Hg\text{-}Ph + C_6H_6$$

$$CH_3\text{-}HgCl + HS\text{-}C_2H_4\text{-}SH \rightarrow CH_3HgS\text{-}C_2H_4\text{-}S\text{-}HgCH_3$$

(Cross and Jenkins, 1975)

Infrared and Raman spectra showed that phenylmercury (II) amino acid complexes of l-cysteine and dl-penicillamine decomposed in benzene at ambient temperature and formed diphenylmercury (Canty and Kishimoto, 1977).

Studies showed that the blood clearance half-time of mercury was 42 days in lactating women and 75 days in males and nonlactating women (Greenwood et al., 1978).

Studies with mouse liver and kidney showed formation of methylmercury from inorganic mercury by intact cells (chopped tissues) but diminished activity by homogenized tissue (Ishihara and Suzuki, 1976).

The biological $t_{1/2}$ of methylmercury in rainbow trout varied from 202 to 516 days. Elimination varied with temperature: 516 ± 83 days at 0.5 to 4C and 348 ± 78 days at 16 to 19C (Ruohtula and Miettinen, 1975).

In vitro methylation of mercury by rainbow trout could not be demonstrated after administration of mercuric chloride via gills or mouth (Pennacchioni et al., 1976). Studies with ^{203}Hg and plaice (*Pleuronectes platessa* L.) also gave no indication of mercury methylation by this species (Pentreath, 1976a and b). When rainbow trout (*Salmo gairdneri*) were exposed to mercurials, little mercury was bound to soluble low molecular weight proteins of kidney. Kidney of unexposed fish did not contain proteins having molecular weight corresponding to metallothionein. Red blood cells preferentially took up methylmercury (from CH_3HgCl) whereas the kidney preferentially took up methylmercurycysteine. It appeared that amino acids mediated some of the renal mercury uptake and that dissociation of methylmercury from cysteine was required before the methylmercury crossed the RBC membrane. In trout blood, the main transport protein of methylmercury appeared to be hemoglobin (Giblen and Massaro, 1975 and 1977).

Brook trout (*Salvelinus fontinalis*) were exposed to mercuric nitrate for 56 days and held at background levels for 294 days. Tests for mercury over the 50-week period indicated a rapid increase in inorganic mercury during exposure. Methylmercury concentrations increased slowly and at same rate in both control and test fish, indicating a lack of ability to methylate mercury (Huckabee et al., 1978).

Studies showed that vascular plants took up inorganic mercury and emitted it as elemental mercury (Kozuchowski and Johnson, 1978).

Cultures of *Chlorella pyrenoidosa* reduced Hg^{2+}. Volatilization of Hg^0 occurred. *In vitro* studies indicated that the reducing factors had a MW = ca 1200. Loss of mercury appeared to involve chemical, rather than enzymatic, reduction followed by physical diffusion of Hg (Ben-Bassat and Mayer, 1977). In higher plants (*Pisum sativum* and *Mentha spicata*), a major portion of mercury taken up after $HgCl_2$ exposure was tightly bound and unaffected by treatment with ethanol and hydrochloric acid (Beauford et al., 1977).

Although few strains of obligate anaerobes formed methylmercury, most strains of staphylococci, streptococci, yeasts, and *E. coli* isolated from human feces did synthesize methylmercury compounds (Rowland et al., 1975).

Two enzymes were obtained from a plasmid-bearing strain of *E. coli* [J53-1(R831)]. A mercuric reductase, which reduced Hg^{2+} to elemental mercury, contained bound FAD and required NADPH and a sulfhydryl compound. The enzyme had a MW of about 180000 with a subunit molecular weight of about 63000. A second enzyme cleaved carbon-mercury bonds. This mercurial hydrolase required EDTA and a sulfhydryl compound for activity and exhibited a MW of about 43000 (Schottel, 1978).

In vitro studies conducted with sonicated *C. cochlearium* indicated that methylmercury activity was heat stable. Addition of S-adenosylmethionine and tetrahydrofolate increased, by as much as eightfold, the amount of methylmercury formed by the S-30 fraction. In higher animals, this activity was related directly to liver B_{12} content--increased B_{12} content with increased methylmercury activity: yellow fin tuna >> rockfish (*Sebastes iracundus*) > amberjack ≈ skipjack tuna >> swordfish > rock fish (*Sebastodes matsubarae*) > salmon ≈ bovine > shark ≈ porcine (Imura et al., 1977). In other studies, the methylating factor was found to be mainly localized in the precipitate fraction and was not light sensitive (Matsumura et al., 1975).

Sediments from San Francisco Bay produced more methylmercury under anaerobic conditions than under aerobic conditions. The amount of organic material present greatly affected ability to methylate mercury (Olson and Cooper, 1976).

A study of mercury dynamics in the Ottawa River and in aquatic systems provided the following observations and conclusions: (1) most (96%) of the mercury present was in bed sediment; (2) suspended sediments were responsible for downstream transport of 58% of all mercury, water, for 41%; and (3) formation and destruction of methylmercury were in equilibrium fairly rapidly in water and sediment without biological agents, invertebrates, fish, and higher aquatic plants. In a study of mercury (from mercuric chloride) transfer from bed sediments to guppies, the concentration of mercury in the river water was 0.1 to 0.5 ppb during the 142-day study. The calculated rate of mercury release from the sediment indicated a $t_{1/2}$ = 12 to 20 years. The half-life for clearance from the fish was calculated to be in the range of 38-75 days (Kudo, 1976 and 1978).

A salt marsh estuary, which had received large discharges of inorganic mercury, did not contain methylmercury in the sediments or marsh vegetation. Significant concentrations were observed in dominant primary consumers (Windom et al., 1976).

The factor responsible for abiological methylation of mercuric ion in soil was extracted with 0.5 N NaOH. This factor was soluble and lost when diallyzed against distilled water. Although stable to temperatures to 121C, the methylation ability was lost after exposure to UV. Formation of methylmercury was affected by soil texture, moisture, temperature, Hg^{2+} concentration, solution pH, and time (Rogers, 1976 and 1977a and b).

Photolysis of aqueous solutions of mercuric sulfide in the presence of acetate produced methylmercury (Akagi et al., 1977).

In vitro studies using ethylene and acetylene indicated that these and other unsaturated hydrocarbons may be involved in the reduction and conversion of mercurial compounds (DeFilippis and Pallaghy, 1975).

MESUROL [4-Methylthio-3,5-xylyl-N-methyl carbamate]

Blueberry plots were treated with mesurol. Analyses of samples indicated the presence of sulfoxide and sulfone. Mesurol exhibited a half-life of 3-7 days (Greenhalgh et al., 1977).

METHAZOLE (Oxydiazol, Probe, VCS-438) [2-(3,4-Dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione]

Phenyl-^{14}C-methazole was administered daily in capsules to cows and in feed to hens. After 14 days, the maximum residue levels were observed in the liver. The major route of excretion in cows was the urine with about 80% of the doses excreted in this way. Between 65 and 75% of the dose was excreted by hens after 14 days. Results of two-dimensional TLC of residues is summarized.

Metabolite	Cow				Hen	
	Urine	Milk	Liver	Kidney	Liver	Kidney
II. 3-(3,4-dichloro phenyl)-1-methylurea	+	+	+	+	+	+
III. 3,4-dichlorophenylurea	+	+	+	+	+	+
IV. *N*-(2-HO-3,4-dichlorophenylurea)	+	+	+	+	+	+
V. *N*-(2-HO-4,5-dichlorophenylurea)	+	+	+	+	+	+
Unidentified compounds	2	3	3	3	5	5

^{14}C-Methazole was administered as a single oral dose to rats. After 48 h, 58% of the dose appeared in the urine. The major metabolite was identified by MS as *N*-(2-hydroxy-4,5-dichlorophenyl)urea. Other metabolites in urine were identified as *N*-(2-hydroxy-3,4-dichlorophenyl)urea, 3,4-dichlorophenylurea, and 3-(3,4-dichlorophenyl)-1-methylurea. The 5,6- and 6,7-dichloro-2-benzoxazolinones arose as degradation products of the two hydroxy-urea metabolites. The two hydroxy-urea metabolites occurred as glucuronides as well as in the free state. Acid hydrolysis of polar material, after removal of glucuronidase-released material, produced the urea and methylurea. The identity of the conjugates was not determined. The major metabolite in feces was 3,4-dichlorophenylurea (Dorough et al., 1974).

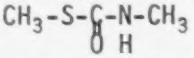
When applied to cotton roots or foliage, methazole-^{14}C was metabolized to 1-(3,4-dichlorophenyl)-3-methylurea (DCPMU) and 1-(3,4-dichlorophenyl)urea (DCPU). A significant amount of the radioactivity was present as conjugates of proteins or peptides, glucose or other plant constituents. Proteolytic enzymes and β-glucosidase were most effective in releasing the ^{14}C. DCPMU and DCPU were released predominantly (Foy et al., 1973).

Acid hydrolysis of the water soluble fraction indicated the presence of conjugates of compounds II and III in urine, milk and liver and kidney of cow and hen, compound IV in milk and kidney of cow and hen liver; compound V in all but cow urine. Conjugates of three of the five unidentified compounds were observed in milk and one was observed in liver and kidney of cow and hen (Atallah et al., 1976).

When incubated in soil at 25C, methazole was unstable and declined following first-order kinetics. The half-life ranged from 2.3 to 5.0 days. Compound II was the major degradation product observed. Compound III was observed but never in amounts greater than 1% of the applied herbicide (Brockman and Duke, 1977; Swoboda and Merkle, 1977; Walker, 1978b). Other studies indicated that methazole was degraded through compounds II and III to 3,4-dichloroaniline (Walker and Roberts, 1978). Studies in sandy loam soil also indicated that methazole degradation to compound II was chemical in nature and that the second step to compound III is microbiological (Walker et al., 1975a).

METHOMYL (Lannate) [*S*-Methyl-*N*-(methylcarbamoyloxy)thioacetamidate]

^{14}C-Labeled methomyl was administered to a rat. Within 72 h, about 75% of the label was expired as $^{14}CO_2$ and acetonitrile. Urinary metabolites were not completely characterized but did not include methomyl, the sulfoxide, the sulfone, or the corresponding oxime (Harvey, 1974).

Albino rats were administered radiolabeled [$^{14}C=O$] and [$^{14}C=N$]methomyl in corn oil. Volatile materials were trapped. Both labeled CO_2 and acetonitrile were identified. The level of urinary radiocarbon from [$^{14}C=O$] label was very low and metabolites were not identified. The data indicated that *syn*-methomyl was partially isomerized to the *anti*-isomer prior to ester hydrolysis. The *syn*-oxime then metabolized to $^{14}CO_2$ whereas ^{14}C-acetonitrile was formed from the *anti*-isomer. On the basis of these observations, it was proposed that the immediate precursors were  $CH_3{-}S{-}\underset{\underset{O}{\|}}{C}{-}\underset{H}{N}{-}CH_3$ and $(CH_3{}^{+}C{=}N{-}S{-}CH_3)X^-$ from the *syn* and *anti* oximes, respectively (Huhtanen and Dorough, 1976).

Two strains of European corn borer (*Ostrinia nubilalis*) were exposed to methomyl. Following injection, the Geneva strain degraded methomyl 4 times faster than the Valley strain. Most of the loss was in the form of CO_2. Water-soluble products could not be cleaved by acid or enzymes and were presumed to be natural products which had incorporated ^{14}C from methomyl. Some of the oxime may have been conjugated or unchanged. *In vitro*, methomyl degradation to CO_2 or acetonitrile was only a minor pathway (Kuhr and Hessney, 1977).

In plants, the half-life was 3 to 7 days. The non-polar fraction consisted of normal plant lipids with ^{14}C incorporated into the commonly occurring fatty acids. The polar fraction contained radiolabeled acids, sugars and compounds that would be expected from normal plant biochemistry and take up of $^{14}CO_2$ or ^{14}C-acetate. Soil treated with methomyl, after one month, had traces of methomyl and its oxime in addition to a small polar fraction (Harvey, 1974).

In field studies, methomyl applied to tobacco at the rate of 88 and 113 ppm dropped to 0.7 and 2.8 ppm after 5 days; and at the rate of 44 and 105 ppm, to 1.4 and 4.1 ppm after 5 days. After 9 days, 99% of the residues had disappeared in both cases. There was a 96% loss of methomyl during flue-curing (Leidy et al., 1977).

In tobacco-growing soils, microbial transformation of methomyl exhibited a 7-14-day lag. In enriched soil, there was no lag phase (Fung and Uren, 1977).

METHOXYCHLOR (MeOCl, DMDT) [2,2-Bis(p-methoxyphenyl)-1,1,1-trichloroethane]

Methoxychlor was fed daily to sheep. At an intake level of 250 ppm (dietary level), residues in the subcutaneous fat of the sheep did not plateau through 10 weeks whereas at 2500 ppm a plateau was reached after 6 weeks at 24.4 ppm. The sheep were subsequently placed on insecticide-free diets and the half-time for depletion was calculated to average 10 days, independent of the ingestion level (Reynolds et al., 1976).

Methoxychlor was incorporated into humic material by Aspergillus versicolor and was not extracted from the humic acid-MeOCl by benzene. However, incubation with Marasmius oreades did release MeOCl (Mathur and Morley, 1975). Humic acids were synthesized in the presence and absence of methoxychlor. Analyses indicated both humic acids to be similar and that methoxychlor when present, was incorporated into the humic acid (Mathur and Morley, 1978).

In oxygen-free hexane, photolysis caused hydrogen replacement of chlorine to produce 1,1-bis(p-methoxyphenyl)-2,2-dichloroethane (DMDD) and lesser amounts of the ethylene analog (DMDE). In the presence of air, p,p'-dimethoxybenzophenone (MDCO) was the main product. Smaller amounts of DMDD, DMDE and p-methoxyphenol (MP) were also formed. In air-saturated water, photolysis produced DMDE, primarily. This in turn gave rise to p-methoxybenzaldehyde (Zepp et al., 1976).

Photolysis of the MeOCl impurity (I) yielded the phenanthrene II and then the dibenzochrysene III (Mitchell and West, 1978).

The MeOCl degradation product, DMDE, underwent rapid photoisomerization in solution in sunlight. Spectral properties of the DMDE photproduct indicated a mixture of cis- and trans-1-(2-chloro-4-methoxyphenyl)-1-(4-methoxyphenyl)-2-chloroethylene. GLC, HPLC, GC-MS, GC-IR, and NMR, in conjunction with syntheses of the isomers, were used to confirm the identity. Two other compounds were identified as p,p'-dimethoxybenzophenone and 1,1-bis-(p-methoxyphenyl)-2-chloroethylene (Zepp et al., 1977).

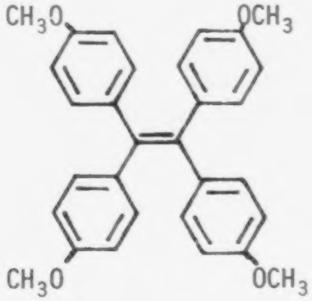
In water, the major products of MeOCl hydrolysis at pH 7 were anisoin, anisil, and DMDE. The half-lives of MeOCl and its transformation products were determined at pH 5 and 27C in water.

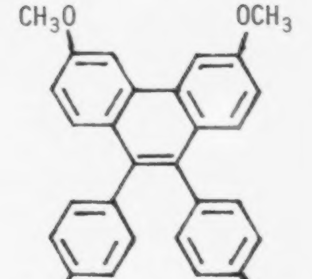
Compound	$T_{1/2}$ (yr)
MeOCl	1
DMDE	>10
DMDD	17
DMDMS	100

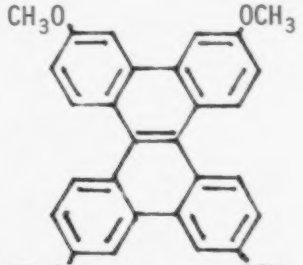
(Wolfe et al., 1976c and 1977b)

Methoxychlor was added to milk and irradiated. Products of degradation identified included: p-methoxyphenol; p-methylanisol; MeOCl-DDE; p,p'-dimethoxybenzophenone; 1,1,4,4-tetrakis(p-methoxyphenyl)-2,3-dichloro-2-butene; and 1,1,4,4-tetrakis(p-methoxyphenyl)1,2,3-butatriene (Li and Bradley, 1969).

Methoxychlor and three analogs (the chloropropane and nitropropane analogs and dianisylneopentane) were administered to housefly, salt marsh caterpillar and mouse and incubated with mouse and sheep liver microsomes. The metabolites were primarily mono- and bis- phenols (Coats, 1975).







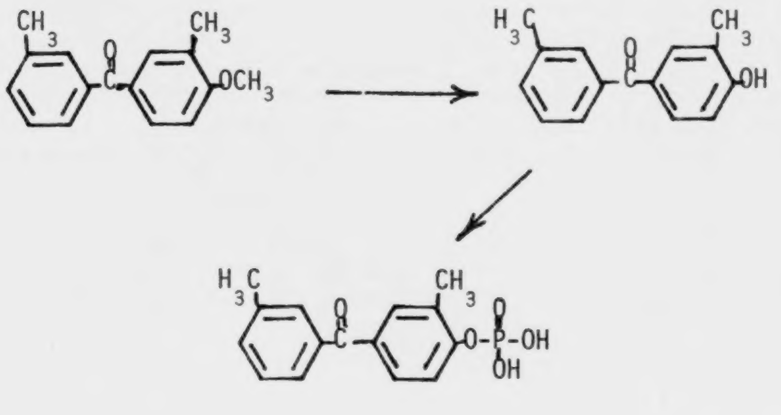
METHOXYPHENONE (NK-049) [3,3'-Dimethyl-4-methoxybenzophenone]

[^{14}C-Carbony]NK-049 was orally administered to female Wistar rats. Distribution of the ^{14}C into tissues was rapid, as was excretion via urine and feces. Within 24 h almost 60% appeared in feces and 36% in urine. Analyses indicated that the major ^{14}C-compound in feces (75% of the ^{14}C present) was unchanged NK-049. In the urine, 10 metabolites were observed and identified by TLC, GLC and MS.

II. 4-HO-NK-049
III. 4-HO-3-hydroxymethyl-3'-methylbenzophenone
IV. 3-carboxy-4-HO-3'-hydroxymethylbenzophenone
V. 3,3'-dicarboxy-4-hydroxybenzophenone
VI. 3-carboxy-4-methoxy-3'-methylbenzophenone
VII. 3,3'-dicarboxy-4-methoxybenzophenone
VIII. 4-HO-3'-hydroxymethyl-3-methylbenzophenone
IX. 3'-carboxy-4-hydroxy-3-methylbenzophenone
X. 3'-carboxy-4-hydroxy-3-hydroxymethylbenzophenone
XI. 3'-carboxy-3-hydroxymethyl-4-methoxybenzophenone

(Fuji et al., 1976).

Methoxyphenone was applied to rice (tolerant) and barnyardgrass (susceptible) plants. Penetration in rice was slow but rapid in barnyardgrass leaves. Conversion of radioactivity from acetone-chloroform soluble form to water-soluble form was rapid. Metabolites were not identified (Fujii et al., 1978). Soil mircoorganisms in paddy soils O-demethylated methoxyphenone and then phosphorylated the hydroxy analog (Kurozumi et al., 1978).



3-Methylphenyl *N*-propylcarbamate

When the subject compound was incubated with microsomes plus $NADPH_2$, eight metabolites were observed and identified as: 3-methylphenol; 3-hydroxymethylphenyl *N*-propylcarbamate; 3-hydroxymethylphenol; 3-carboxyphenyl *N*-propylcarbamate; 3-methylphenyl carbamate; 3-methylphenyl *N*-(2'-hydroxypropyl)carbamate; 3-methylphenyl *N*-(3'-hydroxypropyl)carbamate; and 3-methyl-4-hydroxyphenyl *N*-propylcarbamate. The probable formation of the *N*-(1'-hydroxypropyl)carbamate analog was indicated by the formation of 3-methylphenyl carbamate, the hydrolysis product (Yamamoto et al., 1978).

Methylphosphonofluoridate

I. *O*-(1,2,2-Trimethylpropyl) methylphosphonofluoridate
II. *O*-(Isopropyl) methylphosphonofluoridate
III. *O*-(Cyclohexyl) methylphosphonofluoridate

Studies with methylphosphonofluoridates demonstrated that actively respiring wheat plants absorb these compounds from the vapor phase. Translocation within the plants was also shown. In addition to unchanged material, the alkyl hydrogen methyl phosphonate of each of these three compounds was found in the wheat plants. The methyl phosphonic acids of I and III were also observed but that of compound II was not detected (Howells et al., 1976).

METRIFONATE (Trichlorfon, Trichorphon, Chlorophos, TCF) [O,O-Dimethyl 1-hydroxy-2,2,2-trichloroethylphosphonate]

TCF-12 (Lauroyl trichlorfon) [O,O-Dimethyl 1-(n-dodecanoyloxy)-2,2,2-trichloroethylphosphonate]

When applied to foliage of Douglas fir, TCF residues declined rapidly. Residues on grass and willow were greater than on Douglas fir. While TCF-12 residues on foliage declined at the same rate as TCF, TCF-12 disappeared more slowly from water than did TCF (Pieper and Richmond, 1976).

Studies indicated that, after i.p. injection of metrifonate in mice, chemical formation of DDVP occurred in the brain (Nordgren et al., 1978).

MEXACARBATE (Zectran) [4-Dimethylamino-N-methyl-3,5-xylylcarbamate]

Hydrolysis of mexacarbate produced 4-dimethylamino-3,5-xylenol, 4-amino-3,5-xylenol, 2,6-xyloquinol, 2,6-xyloquinone and an unidentified compound. GC/MS was used to identify these compounds (Mauck et al., 1977).

In buffered solutions, hydrolysis followed first-order kinetics. $T_{1/2}$ values are tabulated.

	$T_{1/2}$		
	Temperature (C)		
pH	10	20	28
5.94	105.1 d	46.5 d	37.3 d
7.0	75.5	25.7	6.9
8.42	35.4	4.6	1.3

(Matthews and Faust, 1977)

In fresh water containing mexacarbate, decomposition products identified included 4-methylamino-N-methyl-3,5-xylylcarbamate, 4-amino-N-methyl-3,5-xylylcarbamate, 4-methylformamido-N-methyl-3,5-xylylcarbamate, 4-dimethylamino-N-hydroxymethyl-3,5-xylylcarbamate, 4-dimethylamino-3,5-xylenol, and a previously unreported compound identified as 2-hydroxy-3,5-dimethyl-p-benzoquinone. This was identified by GLC, TLC, IR and UV (Roberts et al., 1978).

MH (Maleic hydrazide) [1,2-Dihydropyridazine-3,6-dione]

Hepatic microsomes, from phenobarbital induced rats, were not able to degrade MH (Nelson and Kearney, 1977). When applied to silver maple (*Acer saccharinum* L.) and American sycamore (*Platanus occidentalis* L.) seedlings, MH translocated to all parts of the plant. In the plant tissue, a metabolite was formed. Hydrolysis products of the metabolite indicated a conjugate of MH and glucose (Domir, 1978). When applied to tobacco plants, ^{14}C-MH was rapidly translocated to growing tissues. Translocation to roots also occurred. A small amount of $^{14}CO_2$ evolved. The major metabolite in foliar tissues was identified as the β-D-glucoside of MH (Frear and Swanson, 1978).

Alcaligenes faecalis, grown in the presence of diethylammonium MH, oxidized MH as well as the MH salt. No metabolites were identified (Magee and Colmer, 1966).

When *Saccharomyces cerevisiae* were incubated with ^{14}C-MH, analyses showed that MH was taken up and incorporated into the RNA of this yeast (Callaghan et al., 1966).

^{14}C-MH was added to unsterilized soil. After 255 days, 56% of the ^{14}C evolved as $^{14}CO_2$ whereas only 5% evolved from sterilized soil (Helweg, 1975).

Pyrolysis of MH at 900C produced a variety of organic compounds. Those identified are summarized.

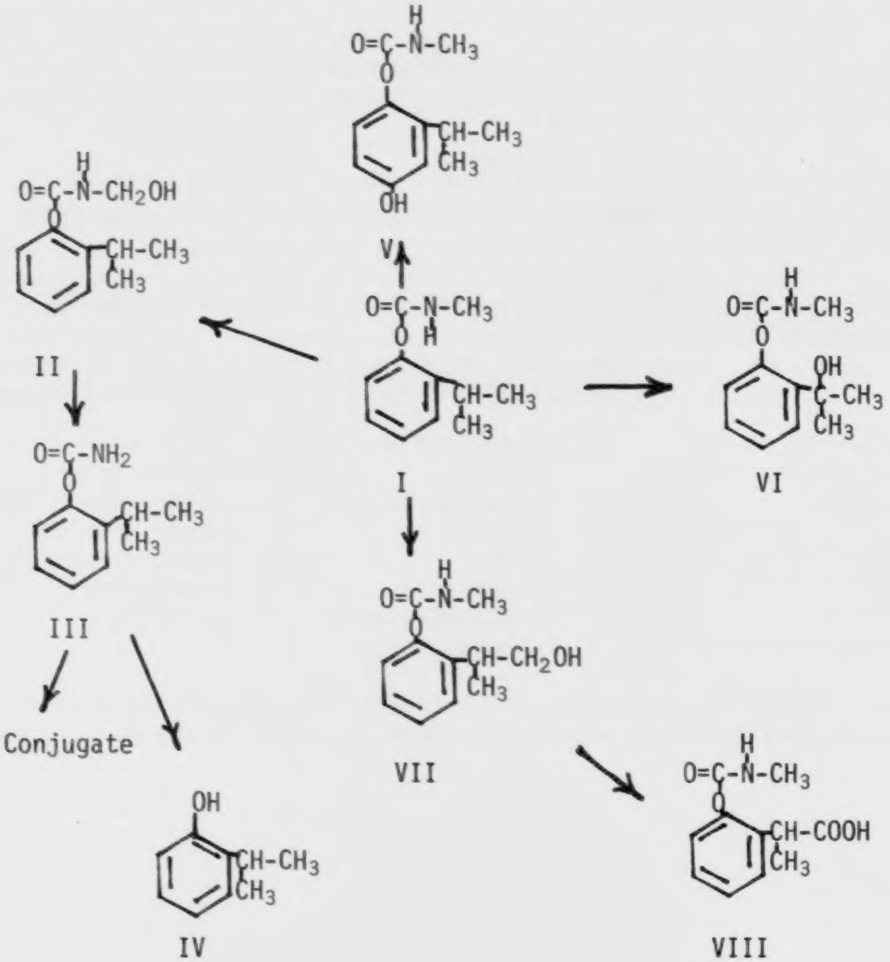
MH pyrolysis products (900C)

carbon monoxide
carbon dioxide
benzene
acrylonitrile
acetonitrile
propionitrile
toluene
cyanopropene(s)
cyanobutadiene(s)
styrene
2-vinylpyridine
pyrrole
indene
benzonitrile
dicyanoethylene
cyanotoluene(s)
aniline
naphthalene
quinoline
benzylcyanide
2-methylnaphthalene
1-methylnaphthalene
pyridine

At 650C, traces of hydrazine, which reacts very rapidly to products like acetaldezine and acetonitrile, were observed (Harke et al., 1973).

MIPCIN (MIPC) [2-Isopropylphenyl *N*-methylcarbamate]

When applied to rice plants, MIPC was easily absorbed from both roots and leaves. Twenty-four radioactive spots were observed by autoradiography after TLC separation. The predominant metabolites observed in straw from the rice were identified as the 2-hydroxyisopropyl (VI) and the *N*-hydroxymethyl (II) analogs. Other compounds observed in rice plants included the *N*-demethyl (III), 4-hydroxyphenyl (V), and 1 hydroxyisopropyl (VII) MIPC analogs, 2-isopropylphenol (IV) and conjugates of these metabolites. Chromatography of soil extracts showed the presence of 16 spots by autoradiography. Compounds II, III, IV, VI and VII appeared as the main metabolites. Compound VIII was also observed. $^{14}CO_2$ evolution from ^{14}C-labeled MIPC was also observed (Ogawa et al., 1977).



MNFA (Nissol) [N-Methyl N-(l-naphthyl)fluoroacetamide]

Studies indicated that mammals, houseflies, and two-spotted spider mites accumulated citrate following treatment with nissol (Johannsen and Knowles, 1972; Noguchi et al., 1968). This indicated hydrolysis to monofluoracetate, formation of fluoroacetate and inhibition of aconitase.

Metabolism studies of nissol in rats, guinea pig, houseflies and two-spotted spider mites indicated conversion to N-methylnaphthylamine and then l-naphthylamine in addition to monofluoroacetate (Knowles, 1974 and 1976; Shrivastava and Knowles, 1971; Noguchi et al., 1968).

Other studies have also indicated hydrolysis of MNFA to fluoroacetic acid, since N-methyl-l-naphylamine was detected, in rats, houseflies (*Musca domestica* L.) and two-spotted mites (*Tetranychus urticae* Koch) (Shrivastava and Knowles, unpublished data, in Johannsen and Knowles, 1972). In two spotted mites exposed to MNFA, citrate levels increased substantially (Johannsen and Knowles, 1972).

MONENSIN

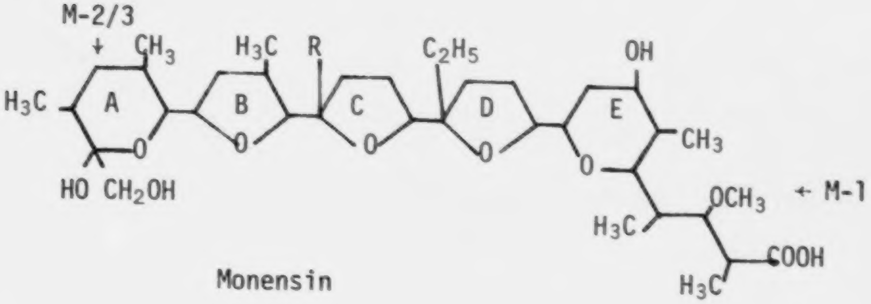
When monensin was orally administered to steers, excretion of the material was rapid and about 90% of the dose appeared in feces. Low levels also appeared in the liver (Herberg et al., 1978). In cattle and rats, monensin gave rise to many compounds with patterns qualitatively similar but quantitatively different. Mass spectra were used to tentatively identify six of the metabolites (Donoho et al., 1978).

M-1. O-demethyl analog.

M-2 and M-3. Epimers. Hydroxylation.

M-4. O-demethyl analog plus hydroxylation between rings B and C.

M-5 and M-6. Hydroxylation between rings B and C.



Monensin

MORESTAN (Oxythioquinox, Chinomethionat, Quinomethionate) [6-Methyl-2-oxo-1,3-dithiolo[4,5-b]-quinoxaline]

Under alkaline conditions morestan hydrolyzes to 6-methyl-2,3-quinoxalinedithiol (QDSH).

In two-spotted spider mites (*Tetranychus urticae* Koch), morestan was metabolized to QDSH both *in vivo* and *in vitro*. Some irreversible binding to protein occurred in the mite homogenate as well as in brain, liver and blood of treated rats (Aziz and Knowles, 1973; Knowles, 1974 and 1976).

In plants and rats, hydrolysis is the predominant pathway of metabolism and the major product is QDSH (T.B. Waggoner, personal communication 1971, from Aziz and Knowles, 1973).

MS-222 (Tricaine methanesulfonate) [Ethyl *m*-aminobenzoate methylsulfonate]

Freshwater and saltwater fish hydrolyzed MS-222 with formation of *m*-aminobenzoic acid. Gallbladder bile contained high concentrations of unidentified polar metabolites. In addition to this, the amine is subject to *N*-acetylation (Allen et al., 1978).

N-2596 [S-(4-Chlorophenyl) O-ethyl ethylphosphonodithioate]

The primary observed metabolites arose from 4-chlorothiophenol by S-conjugation, S-methylation and S-oxidation, ring hydroxylation and C-conjugation (Miaullis et al., 1976). In rats given a single oral dose of radiolabeled N-2596, within 4 days most of the ^{14}C was excreted in the urine as the glucuronide and sulfate of 4-chloro-3-hydroxyphenyl methyl sulfone. Metabolites observed in urine also included 4-chlorophenyl methyl sulfoxide and sulfone, 4-chloro-3-hydroxyphenyl methyl sulfone, 4-chlorobenzene sulfonic acid, and the glucuronide of 4-chlorothiophenol. Three other metabolites were observed but not identified (Miaullis et al., 1976 and 1977a).

N-2596 was applied to a soil-corn-water ecosystem. The half-life appeared to be 6-7 months. Analyses of soil samples showed the presence of the oxon, p-chlorophenyl methyl sulfoxide and sulfone. From the water percolating through the soil, the sulfoxide and p-chlorobenzene sulfonic acid were observed. Corn plants contained the sulfone and what appeared to be the p-chlorobenzene sulfonic acid (Lichenstein et al., 1977b).

1,8-NA [1,8-Naphthalic anhydride]

^{14}C-labeled 1,8-NA was applied to corn seeds and then planted in jars. Plants were sampled from the 4th to 11th day after emergence. Analyses indicated the presence only of one metabolite, identified as 1,8-naphthalic acid. However, the studies showed this to be an artifact produced in the hot GLC column. No detectable residue of 1,8-NA was found in corn plants beyond the 5th or 6th week after emergence. In soil, 1,8-NA was rapidly lost during the growing season (Riden and Asbell, 1974).

NICOTINE [1-Methyl-2-(3-pyridyl)pyrrolidine]

N-methyl-^{14}C and 2'-^{14}C-labeled nicotine were administered to mice. In the bronchial mucosa, N-demethylation was believed to occur with incorporation of the methyl group into mucosal cell constituents. Radioactivity was retained in the urinary bladder wall and bronchial walls for about one month after administration. Twenty minutes after administration of the nicotine to pigmented mice, cotinine and γ-(3-pyridyl)-γ-oxo-N-methylbutyramide were observed in chloroform extracts of the eyes in addition to unchanged nicotine. Extracts of respiratory tract tissues contained hydroxycotinine as well as the previous three compounds. Other compounds were observed but not identified (Szuts et al., 1978). In male Fischer-344 rats, after i.v. administration of ^{14}C-nicotine, the biological half-life of nicotine in plasma was 0.96 h. The plasma half-life of the metabolites was 23.2 h (Adir et al., 1976).

In rabbit lung, nicotine clearance was quite low and metabolism negligible. Formation of cotinine and nicotine-1'-oxide occurred at first-order rates (McGovren et al., 1976). In studies with dog lung preparations, cotinine and nicotine-1'-oxide were also observed (Turner et al., 1975).

After oral administration of (S-)-cotinine-N-oxide to rabbits and dogs, analyses of urine indicated the presence of cotinine, demethylcotinine, hydroxycotinine, and allohydroxycotinine. From urine of dogs, 34% of the administered dose was recovered; from urine of rabbits, 21% of the dose was recovered (Yi et al., 1977).

Nicotine was administered to a rabbit, cat, rat and squirrel monkey. Differences in excretion rates were observed in all four species. In each case cotinine was observed (Turner, 1975).

In studies with bacteria (*Arthrobacter globiformis*), nicotine-N-oxide was metabolized to N'-methylmyosmine and 4'-keto-4'-(3-pyridyl)butyric acid in addition to four unidentified compounds. When nicotine was incubated with the bacteria, 6-hydroxynicotine and 6-hydroxy-N'-methylmyosmine were observed (Maeda et al., 1978).

The stereoselective metabolism of nicotine to the 1'-N-oxide analog was re-interpreted in light of the reassignment of the absolute configuration of the *cis*- and *trans*-1'-N-oxides (Testa et al., 1976).

NITRAPYRIN (N-Serve) [2-Chloro-6-trichloromethylpyridine]

N-Serve, applied to soil, was lost by degradation to 6-chloropicolinic acid. The $t_{1/2}$ was 22 days at 20C. It was also lost from soil by volatilization with a $t_{1/2}$ of 4 days at 20C (Redemann et al., 1964).

Studies indicated that nitrapyrin hydrolysis was not affected by pH in range of 2.7 to 11.9 and that temperature was the most important factor affecting nitrapyrin hydrolysis (Hendrickson, 1978).

In buffered distilled water, hydrolysis of nitrapyrin followed first-order kinetics between 6.2×10^{-7} and 8.7×10^{-5}M and was independent of pH. Only 6-chloropicolinic acid was observed (Meikle et al., 1978).

Photolysis of nitrapyrin was studied at 25C in 0.005M phosphate buffer at pH 5.1, 7.1 and 8.0 and in natural water. Over the range of 7.1×10^{-6} to 7.5×10^{-6}M, photolysis was independent of pH and followed first-order kinetics. The half-life was calculated to be 0.5 day. In addition to unidentified polar material, 6-chloropicolinic acid (6-ClPA) and 6-hydroxypicolinic acid (6-OHPA) were observed (Meikle et al., 1978).

NITROFLUORFEN [2-Chloro-4-trifluoromethylphenyl 4'-nitrophenyl ether]

OXYFLUORFEN (RH-2915, GOAL) [2-Chloro-4-trifluoromethylphenyl
3'-ethoxy-4'-nitrophenyl ether]

Metabolism of these two compounds by plants was not extensive. After 4 h, less than 1% of the herbicide was taken up by fababean and green foxtail leaf samples. Using ^{14}C-labeled nitro ring or $^{14}CF_3$-oxyfluorfen gave no differences in the percentage of metabolism (Vanstone and Stobbe, 1978).

In albino rats orally dosed with oxyfluorfen, the major excretory route was via the feces (95% of the dose), of which about 75% was unchanged oxyfluorfen. Analyses of feces also showed the presence of:

5-(2-chloro-4-trifluoromethylphenoxy)-2-nitrophenol
4-(2-chloro-4-trifluoromethylphenoxy)-2-ethoxybenzeneamine
N-[4-(2-chloro-4-trifluoromethylphenoxy)-2-ethoxyphenyl]acetamide
N-[4-(2-chloro-4-trifluoromethylphenoxy)-2-hydroxyphenyl]acetamide

(Adler et al., 1977)

NORFLURAZON (SAN-9789) [4-Chloro-5-methylamino-2-(α,α,α-trifluoro-*m*-tolyl)-3(2H)-pyridazinone]

SAN-6706 [4-Chloro-5-dimethylamino-2-(α,α,α-trifluoro-*m*-tolyl)-3(2H)-pyridazinone]

SAN-9774 [4-Chloro-5-amino-2-(α,α,α-trifluoro-*m*-tolyl)-3(2H)-pyridazinone]

^{14}C-SAN-6706 was added to solutions in Ehrlenmeyer flasks in which cranberry cuttings were propagated. Subsequently, leaf, shoot and root were analyzed. Within one day, norflurazon and an unidentified metabolite were detected in the roots. After 15 days, in addition to norflurazon, SAN-9774 was identified in leaf, shoot and root. When norflurazon was applied to the plants, SAN-9774 and an unidentified metabolite were observed in leaf, stem and root after 8 days (Yaklich et al., 1974).

When applied to soybeans, SAN 6706 was converted to the desmethyl analog (Motooka, 1973). In soybeans and sicklepod (*Cassia obtusifolia* L.), the primary metabolic pathway was *N*-demethylation to norflurazon and desmethyl SAN 9774. Another pathway present in the plant roots produced polar compounds (Motooka et al., 1977). Corn also demethylated SAN 6706 to produce the demethylated analog SAN 9789 (Strang, 1973).

In sandy loam soil, at 5, 20, and 35C, SAN 6706 dissipation was 10, 80 and 97% after 210 days and was converted to its monomethyl and demethylated metabolites. At 20 and 35C, SAN 6706 exhibited a $t_{1/2}$ = 50 and 9 days, respectively (Rahn and Zimdahl, 1973). The half-life of SAN 9789 in soil was about 8 months. The demethylated metabolite of SAN 9789 was observed (Rogers, 1973).

ORDRAM (Molinate) [*S*-Ethyl hexahydro-1H-azepine-1-carbothioate]

Ordram was applied in granular form to flooded rice paddy. The half-life of ordram was less than 100 h. No significant residues were present in the water after 192 h (Deuel, 1975).

Ring-2-^{14}C-ordram was administered as an oral dose to rats. Most (88%) was excreted in the urine. Less than 1% was expired and no significant differences between male and female rats were observed. Metabolism was primarily via sulfoxidation and conjugation with glutathione. Within 48 h after dosing of rats with ^{14}C-ring-labeled ordram, 97% of the ordram was excreted, mostly via urine (88%). Analyses and identification involved TLC, and mass and NMR spectra. Metabolites were identified as:

I. Ordram sulfoxide
II. hexamethyleneimine (HMI)
III. Ordram mercapturate
IV. 4-OH-ordram
V. 3-OH-ordram
VI. 4-hydroxy-ordram-*O*-glucosiduronic acid
VII. 3-hydroxy-ordram-*O*-glucosiduronic acid
VIII. 4-hydroxyhexamethyleneimine (4-OH-HMI)
IX. 3-hydroxyhexamethyleneimine (3-OH-HMI)
X. 4-OH-HMI glucuronide
XI. 3-OH-HMI glucuronide
XII. *S*-ethyl 5-formylpentyl thiocarbamate
XIII. 1-aza-7-oxa-8-oxo-bicyclo[4.2.1]nonane

(DeBaun et al., 1978a,b and c)

Micrococcus sp. 22r degraded ordram via *S*-ethyl-1-(2-hydroxy)-hexamethyleniminothiocarbamate, 1-hexamethyleniminothiocarbamic acid, *S*-ethyl-(1,2Δ-2-hydroxy)-hexamethyleniminothiocarbamate, *S*-ethyl-(2-oxo)-1-hexamethyleniminothiocarbamate. With *Bacillus* sp. 24 and *Nocardia* sp. 119, ordram gave rise to oxo- and dioxo metabolites. Oxidation of the ethyl group to a carboxyl group was observed. There was no hydrolysis of the ethyl group (Golovleva et al., 1978).

The microsomal monooxygenase of carp (*Cyprinus carpio* var. Yamato koi) converted ordram to the sulfoxide and two other compounds containing a hydroxyl group on the azepine ring (Lay et al., 1978).

In a rice field, ordram was half gone in 3 days. About 80% of the ordram was lost by vaporization (Bowers et al., 1976).

Studies with molinate indicated that degradation of molinate was primarily photochemical after application to a rice field. Although the molinate UV absorption maximum is 225 nm and would not be expected to undergo photolysis, the presence of the naturally occurring photosensitizer tryptophan promoted photodecomposition. A proposed pathway was indicated (Soderquist et al., 1977).

Field studies conducted under flooded rice cultivation indicated that molinate had a half-life of 74 to 118 h in intermittent flow plots and 37 to 71 h in continuous flow plots. The half-life was not dependent on application rate (Deuel et al., 1978).

ORTHONIL [α-Chloro-β-(3-chloro-o-tolyl)propionitrile]

Ring-tritiated and ^{14}CN-orthonil were applied to roots or segments of intact seedlings of mung beans. Analyses of the plants indicated the presence of the following metabolites:

II. α-chloro-β-(3-chloro-o-tolyl)propionic acid
III. α-hydroxy-β-(3-chloro-o-tolyl)propionitrile
IV. α-(3-chloro-o-tolyl)acetic acid

Ether insoluble materials were also present as, in part, glucosides. One of these was identified as the α-glucoside of compound II. Labeled asparagine was observed and probably arose from incorporation of ^{14}CN (Vendrig and Dierickx, 1976).

ORTHENE (Acephate) [*O*,*S*-Dimethyl *N*-acetylphosphoramidothioate]

MONITOR (Methamidophos, Acephate-met, Tamaron, Ortho 9006) (*O*,*S*-Dimethyl phosphoramidothiolate]

Toxicity of orthene to insects was related to monitor production and degradation. *O*- and *S*-Demethylation, prior to deacetylation, contributed to resistance. With excised cotton leaves, orthene was converted to some monitor as well as *O*-demethyl orthene (Larson, 1976).

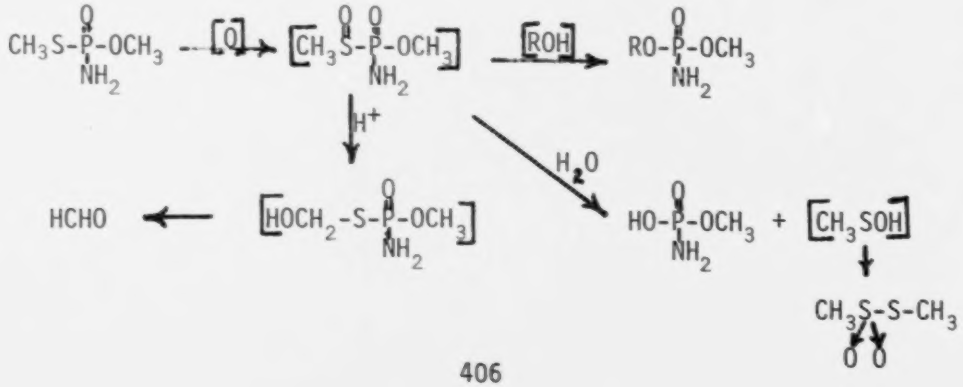
In vivo studies failed to disclose metabolism of methamidophos. However, *in vitro* studies with cockroach guts or mouse liver slices indicated the presence of 4 metabolites in the former and three in the latter. Autoradiography and paper chromatography showed the presence of compounds III, V, VI and VII in cockroach guts and V, VI and VII in mouse liver slices (Khasawinah et al., 1978).

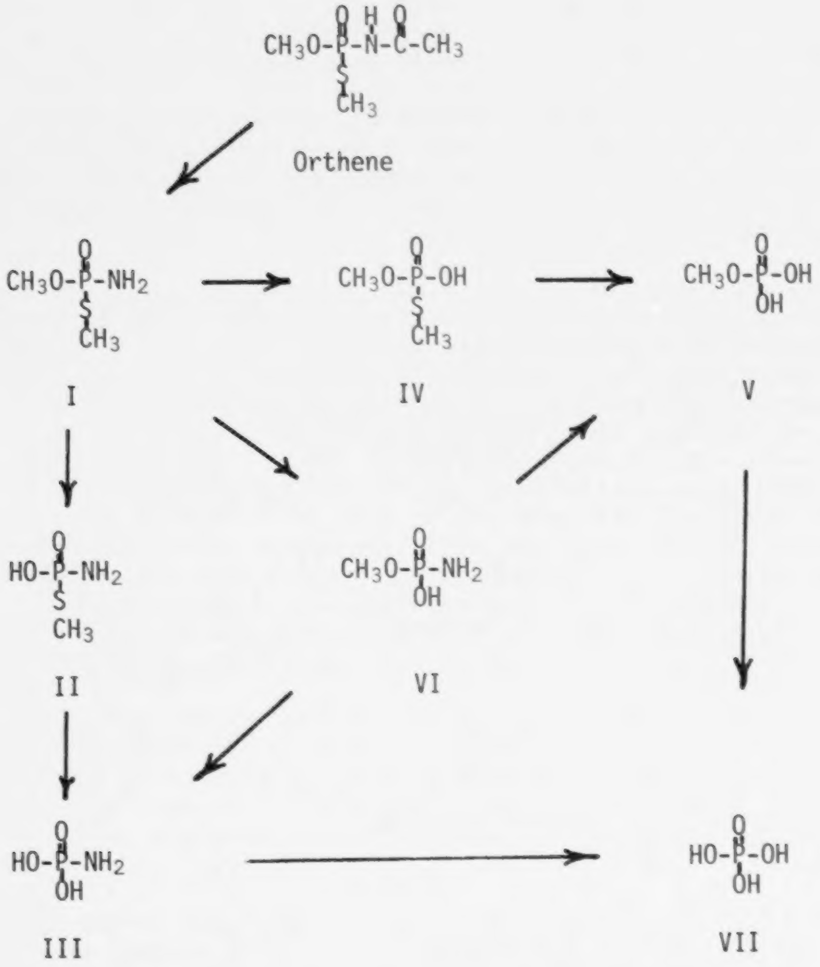
Studies with *N*-propionyl and *N*-*n*-hexanoyl analogs are summarized in the following table.

	Metabolites observed			
	R			
	Propionyl		Hexanoyl	
	Houseflies	White mouse	Houseflies	White mouse
Methamidophos	+	+	+	+
O-demethyl	+	+	+	+
Compound IV			+	+
Compound II			+	+
Conjugates			+	+
CO_2	+	+	+	+

(Kao and Fukuto, 1977)

Oxidation of methamidophos with *m*-chloroperbenzoic acid produced an active cholinesterase inhibitor believed to be the unstable methyl sulfoxide. Some formaldehyde and methyl methanethiolsulfonate were also formed. A pathway was suggested (Eto et al., 1977).



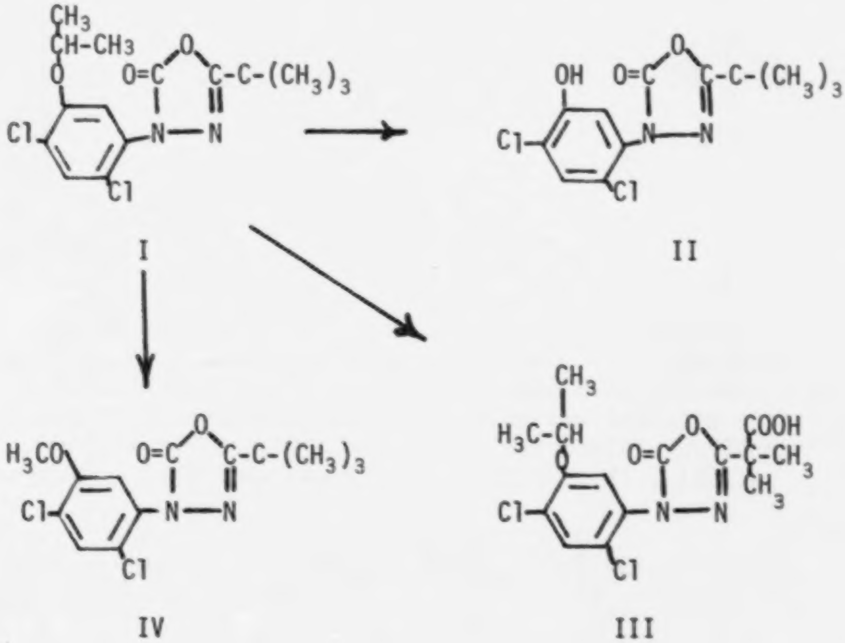

Orthene
I
IV
V
II
VI
III
VII

OXADIAZON (Ronstar) [2-(*t*-Butyl)-4-(2,4-dichloro-5-isopropyloxyphenyl)-Δ^2-1,3,4-oxadiazolin-5-one]

Dairy cows and quail were fed oxadiazon in their diets. Residues were found in tissues of both species and in the cow milk. After withdrawal, residues were eliminated within 12 days (Guardigli et al., 1976).

In an aquatic ecosystem, oxadiazon was not accumulated by organisms to high levels. Compound IV was observed in fish (*Gambusia affinis*). In water, algae, snails, and fish, compound II was observed. Some polar material and five unidentified metabolites were also present (Ambrosi et al., 1978).

In soil, oxadiazon was slowly degraded. A small amount of $^{14}CO_2$ was formed. Some ^{14}C was bound in the soil in the fulvic acid and humic acid. In addition to unchanged oxadiazon, compounds II and III were identified by TLC, GLC and MS. Compound IV was observed in two TLC systems (Ambrosi et al., 1976b and 1977b).


I

II

IV

III

OXAMYL (Vydate, DPX-1410) [Methyl N',N'-dimethyl-N-(methylcarbamoyloxy)-1-thiooxamimidate]

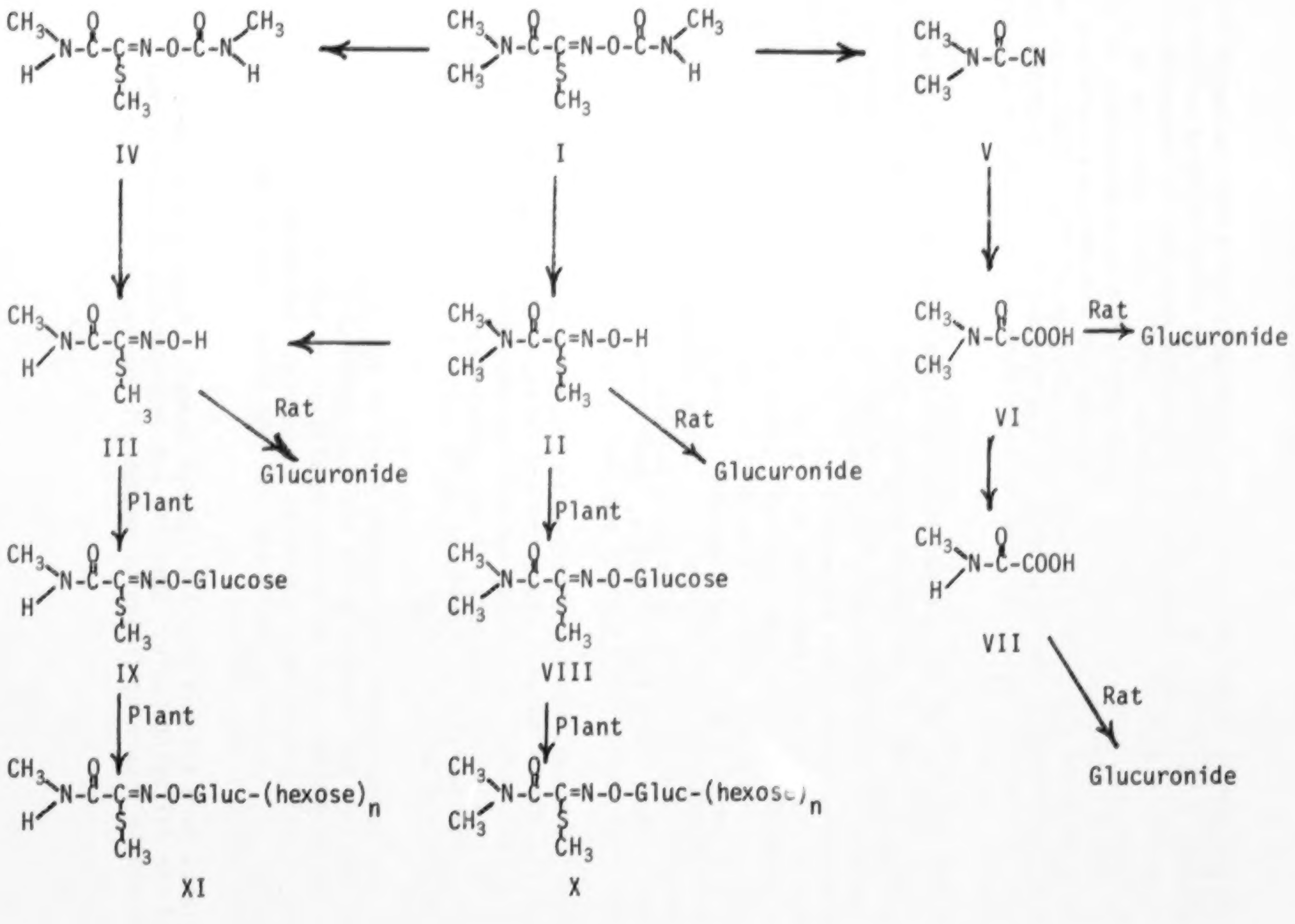
Incubation of oxamyl with rat liver microsomes indicated two major metabolic pathways. Oxamyl was hydrolyzed to methyl N',N'-dimethyl-N-hydroxy-1-thiooxamimidate (DMHT). Enzymatic degradation converted oxamyl to N,N-dimethyl-1-cyanoformamide (DMCF), which gave rise to N,N-dimethyloxamic acid (DMOA). N-Demethylation gave monomethyl products. When administered to rats, most of the dose was rapidly eliminated in the urine and feces as conjugates of DMHT, DMOA, and their mono-methyl analogs. When rats were dosed orally with DMCF, most of the dose was eliminated as conjugates of the oxamic acids (Harvey and Han, 1977).

Oxamyl metabolism was studied with rat liver microsomes as well as *in vivo*. Analyses of incubation mixtures after 2 h showed the presence of compounds II, III, IV, V and VI in addition to unchanged oxamyl. Compound II also appeared in the controls, indicating formation by hydrolysis rather than enzymatically. Another polar compound observed was not completely identified but is believed to be the glucuronide of compound II. In other studies, oxamyl was fed to Charles River-CD rats in the diet. Within 72 h, most of the dose (68-72%) was excreted via urine as highly polar compounds. They were identified as conjugates of compounds II, III, VI and VII. These conjugates were cleaved by methanolic HCl but not by β-glucuronidase-aryl sulfatase enzyme treatment. When ^{14}C-oxamyl was used, some of the ^{14}C was incorporated in tissue amino acids (Harvey and Han, 1978a).

When ^{14}C-oxamyl was administered to lactating goats, most of the dose was rapidly eliminated via urine and feces. Some $^{14}CO_2$ also formed. No intact oxamyl or related metabolites were detected in milk, blood, urine or tissues; however, ^{14}C was incorporated into lactose, casein, triglyceride fats, and amino acids of protein in blood and tissues (Harvey and Belasco, 1978).

In the peanut plant, the primary route of degradation involved hydrolysis to the oximino which was conjugated with glucose. Other transformations involved mono-N-demethylation and/or addition of additional glucose to the glucose conjugate. Breakdown of ^{14}C-oxamyl and incorporation of the ^{14}C into plant fatty acids was also observed (Harvey, 1976a).

Plants were treated with ^{14}C-labeled oxamyl. Results are summarized in the following table. Some ^{14}C was incorporated into the normal naturally occurring lipids of peanut oil (Harvey et al., 1978c).


I
II
III
IV
V
VI
VII
VIII
IX
X
XI
Rat
Plant
Glucuronide
N-O-Glucose
N-O-Gluc-(hexose)n

Plant	Metabolites identified
Tobacco	II, VI, VIII
Alfalfa	II, VIII
Peanuts	VIII, IX, X, XI
Potatoes	VIII, IX, X, XI
Apples	II, V, IX
Oranges	V, VIII, X
Tomatoes	II, V, VIII

In soil, ^{14}C-oxamyl degraded under aerobic conditions with release of $^{14}CO_2$ (51% in 42 days). Compound II and some unidentified polar material were also observed. Over 30% of the radioactivity remained in the soil as a water-insoluble residue which after extraction with hot 0.1N NaOH, was found to be in various soil fractions: hymatomelanic acid (6%); fulvic acid (62%); α-humus (25%); β-humus (6%). Under anaerobic conditions, 3% of the radioactivity occurred as $^{14}CO_2$. About 41% of the radioactivity appeared as compound II and about 42% as polar material. Only a small amount was unextractable. In a sandy Florida soil and a loamy North Carolina sand, the half-life of oxamyl was 15 and 11 days, respectively, under aerobic conditions. In a Keyport silt loam, the half-life was 6 days under anaerobic conditions (Harvey and Han, 1978b).

In river water, oxamyl was photolyzed quickly to the corresponding oximino compound and to the *syn*-*anti* isomer after a longer time. Both isomers degraded to polar compounds, one of which was identified as *N*,*N*-dimethyloxamic acid. In soil oxamyl degraded rapidly with CO_2 evolution. Traces of the oximino was also observed (Harvey, 1976b).

In aqueous solution, at pH 4.7 oxamyl was stable for 11 days but slowly hydrolyzed to compound II at pH 6.9. At pH 9.1 hydrolysis was rapid--30% in 6 H. When exposed to UV in distilled water, oxamyl decomposition was not rapid. In 7 days, only 39% decomposition occurred. One product observed was believed to be the geometrical isomer of II. In river water exposed to sunlight, oxamyl decomposition was even more extensive, producing compound II and its isomer. Compound VI was also observed (Harvey and Han, 1978b).

PARATHION

ETHYL PARATHION [O,O-Diethyl O-p-nitrophenyl phosphorothionate]

METHYL PARATHION [O,O-Dimethyl O-p-nitrophenyl phosphorothionate]

Ethyl parathion was incubated with hepatic tissue from males and females of nine mammalian species. These studies indicated that male guinea pigs and rats possessed higher desulfurating ability than the females. In general, this ability was in the order hamster > guinea pig > mouse > rat > rabbit > bovine > dog > porcine > cat. Of these animals only in the rat was there a sex difference in hydrolytic rate, male rats possessing higher arylester activity than females. Hydrolytic activity was in the order mouse > bovine > rat > guinea pig > rabbit > hamster > cat > dog > porcine (Whitehouse and Ecobichon, 1975).

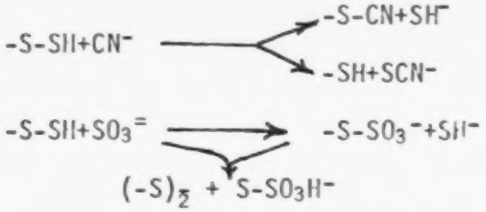
After oral ingestion by humans of methyl and ethyl parathion, urine was collected and analyzed. p-Nitrophenol (PNP), dimethyl phosphate (DMP), and dimethyl dithiophosphate (DMDTP) were observed after methyl parathion ingestion. When ethyl parathion was ingested, p-nitrophenol, diethyl phosphate (DEP), and diethyl thiophosphate (DETP) were observed (Morgan et al., 1977). PNP, DEP, and DETP were also observed in urine from poisoned individuals (Comer et al., 1976).

Binding of ethyl parathion to bovine serum albumin was reversible. The affinity of parathion for bovine and human serum albumins, at pH 7.2 and 4C, was 2.7×10^6 and 1.5×10^6 M^{-1}, respectively. The affinity constants for paraoxon were 6.0×10^3 and 1.6×10^4 M^{-1} for bovine and human serum albumins, respectively (Mourik and de Jong, 1978).

Rabbit hepatic preparations of cytochrome P-450 were used to study ethyl parathion degradation. These studies indicated that the breakdown products paraoxon, diethyl phosphorothioic acid, and diethyl phosphoric acid were nonenzymatically formed from a common enzymatically formed intermediate thought to be a sulfine derivative. The latter would be formed by the mixed function oxidase by addition of an oxygen atom to one of the unshared electron pairs of the thionosulfur (Kamataki et al., 1976).

In vitro studies were conducted with a rat liver microsomal oxidase system. Parathion sulfur was bound to macromolecules, probably as hydrodisulfide, or appeared as the water-soluble metabolites sulfate, thiosulfate and sulfite. Glutathione increased sulfate and thiosulfate production, removed covalently bound sulfur from microsomal membranes, and partially reactivated some enzymes known to be inactivated during parathion metabolism (Morelli and Nakatsugawa, 1978a).

The sulfur binding of parathion to rat liver microsomes was investigated. In other studies, when parathion was converted to paraoxon, only S was concurrently bound to the microsomes. These studies indicated the formation of a hydrodisulfide or polysulfide by combination of the parathion sulfur with cysteine residues of microsomal protein. Similar binding occurred when parathion was incubated with purified rabbit cytochrome P-450 plus NADPH-cytochrome P-450 reductase and NADPH. The sulfur released from parathion occurred as a water-soluble material or in bound form. These studies indicated that this reaction did not result from a secondary sulfitolysis but that it was the result of the reaction of an active form of sulfur directly with microsomes. The reaction of cyanide on S-labeled microsomes to form thiocyanate was consistent with formation of a polysulfide or hydrodisulfide. Chemical reactions did not distinguish between polysulfide and hydrodisulfide. However, the reaction with sulfite to give thiosulfate instead of sulfide was unexpected. This could be explained if the inner sulfur were protected from attack by the bulk of the protein.



(Davis and Mende, 1977)

In male rats, formation of dealkylation and hydrolytic products of ethyl paraoxon were about equal. When enzyme inducing materials were added to liver homogenates and incubated, hepatic paraoxon deethylase activity increased dramatically whereas there was no noticeable change in hepatic phosphatase activity. This effect was not observed in vivo. The use of ^{14}C-ethyl desethyl paraoxon gave rise predominantly to $^{14}CO_2$. When the phenyl group was labeled, desethyl parathion yielded labeled 4-nitrophenol. Paraoxon degradation by liver and lung preparations from male and female rats was only slightly higher in males. Oxidative metabolism, however, was apparently higher in males. In addition to desethyl paraoxon, 4-nitrophenol, diethyl phosphoric acid, and inorganic sulfur were observed (Appleton and Nakatsugawa, 1977).

In other studies, in which ethyl parathion was administered to male Sprague-Dawley rats, diethyl phosphoric acid and diethyl phosphorothionic acid were found in the urine (Bradway et al., 1977).

In other in vitro studies, parathion metabolism by a rat liver mixed function oxidase system and a system containing cumene hydroperoxide and rat hepatic cytochrome P-450 were compared. With each system the products were paraoxon, diethyl phosphate, diethyl phosphorothionate, 4-nitrophenol and inorganic sulfur. With both systems parathion sulfur became bound to proteins of the enzyme systems (Yoshihara and Neal, 1977).

Hepatic preparations from mice metabolized parathion to paraoxon and p-nitrophenol. Hepatopancreas preparations from lobsters did not exhibit detectable mixed function oxidase activity with parathion as a substrate; and no formation of paraoxon or p-nitrophenol was observed even after hepatopancreas subcellular fractions and homogenates were fortified with NADPH, NADH, FAD or FMN (Elmamlouk and Gessner, 1976).

Resistant fish had higher levels of carboxylesterase than did susceptible fish (Gambusia affinis). Carboxylesterase exhibited greater affinity for parathion than did AChE possibly providing protection (Chambers, 1976).

With homogenates of Myzus persicae, the breakdown product of paraoxon was mainly diethyl phosphoric acid. Hydrolysis of ethyl paraoxon was inhibited by the isopropyl and n-propyl analogs (Oppenoorth and Voerman, 1975).

Third stage larvae of resistant and susceptible tobacco budworms (Heliothis virescens F.) were exposed to methyl parathion. Enzyme preparations were also prepared from whole homogenates of third stage larvae. Metabolites identified were the same in both cases: methyl paraoxon, p-nitrophenol, p-nitrophenylglucoside, and desmethyl parathion. Some quantitative differences were noted between resistant and susceptible strains. Studies with fifth stage larvae gave similar results (Whitten and Bull, 1978).

Whole housefly homogenates with glutathione were incubated with parathion. Three compounds were identified by co-chromatography as S-(p-nitrophenyl)glutathione, desethyl parathion and parathion. The studies indicated different enzymes were responsible for the dearylation and deethylation (Motoyama and Dauterman, 1975). A GSH-transferase was obtained from houseflies. With methoxy OP compounds, only the GS-methyl conjugate formed. With ethoxy compounds, GS-ethyl and GS-p-nitrophenyl formed (Motoyama and Dauterman, 1977).

Rat liver glutathione S-transferases were separated on a hydroxyapatite column and numbered I-IV as they eluted. Methyl parathion was incubated with the S-transferase:

Incubation	Product(s)
I + Methyl parathion	S-methyl glutathione and demethyl methyl parathion

III (or IV) + Methyl parathion	S-methyl glutathione, S-*p*-nitrophenylglutathione and dimethyl phosphorothioic acid

(Usui et al., 1977)

Parathion resistant houseflies showed a greater capacity to dearylate paraoxon than did fenthion resistant houseflies. No deethylated metabolites were observed (MacDonald, 1976).

After houseflies (*Musca* sp.) and blowflies (*Lucilia* sp.) were allowed to feed on a 1% solution of *p*-nitrophenol in milk, excreta was collected and analyzed. In addition to the *p*-nitrophenyl glucoside and sulfate, *p*-nitrophenyl phosphate was observed (Heenan and Smith, 1967). *In vivo* studies with houseflies, blowflies, and New Zealand grass grubs were conducted. When injected with *p*-nitrophenol, chromatography and ionophoresis indicated the presence of *p*-nitrophenyl dihydrogen phosphate, *p*-nitrophenyl hydrogen sulfate and *p*-nitrophenyl glucoside (Binning et al., 1967).

Grape juice was fortified with a high level of 25 ppm parathion and incubated with *Saccharomyces cerevisiae* var. *ellipsoideus*. At the end of 12 days, paraoxon, aminoparathion, and *p*-nitrophenol were present in wine and lees (Kawar et al., 1978).

After treatment of a plum orchard with parathion, air samples were collected and analyzed. In the first 21 days, the ratio of paraoxon to parathion was relatively constant. Subsequently, there was conversion to *p*-nitrophenol. This was observed in air samples taken as far as 25 miles from the orchard (Woodrow et al., 1977). When dwarf Eureka lemon trees were treated and placed in an environmental chamber, paraoxon formation was low in the presence of low foliar dust levels even in the presence of ozone. When dust levels were high, paraoxon production increased by a factor of 4. With high dust levels and 300 ppb ozone, paraoxon increased by 30-fold (Spear et al., 1978).

Soil was incubated with ring-labeled methyl parathion. About 32% was bound and unextractable. Worms were placed in the extracted soil for 2 to 6 weeks or oats were grown in it. Analyses indicated that the worms contained sizable ^{14}C residues. While most of the plant residues were extractable, most of the residues in the worms were bound. Most of the ^{14}C residues in the oat greens was benzene soluble; in the seeds and roots, it was water-soluble (Fuhremann and Lichtenstein, 1978).

A mixed bacterial culture, adapted to grow on ethyl parathion as a sole carbon and energy source, was incubated with ethyl parathion. Three pathways of parathion metabolism were observed. In the primary oxidative pathway, parathion was hydrolyzed to *p*-nitrophenol and diethyl phosphorothionic acid. By a second pathway, paraoxon formed and yielded *p*-nitrophenol and diethyl phosphoric acid upon hydrolysis. Under low oxygen tension, a third pathway yielded *p*-amino analog of parathion. Hydrolysis of this compound yielded *p*-aminophenol and diethyl phosphorothionic acid (Munnecke and Hsieh, 1976). Other similar studies, using a parathion-xylene formulation, indicated formation of *p*-hydroquinone from *p*-nitrophenol and/or *p*-aminophenol, followed by hydroxylation to form 1,2,4-benzenetriol. This then degraded by ortho ring cleavage (Munnecke and Hsieh, 1975).

Studies with ^{14}C-ring-labeled parathion indicated formation of compounds which, when added to soil, became bound and unextractable. Soils containing bound residues were not toxic to fruit flies. Under flooded conditions, binding of compounds labeled with ^{14}C doubled and parathion was reduced to aminoparathion. Reinoculation of sterilized flooded soil fully reinstated the binding capacity. An increase in bound residues correlated with a decrease in parathion and an increased amount of *p*-aminoparathion. Aminoparathion was preferentially bound to soil and its binding within 2 h was 30x greater than that of parathion (Katan et al., 1976; Katan and Lichtenstein, 1977).

By enrichment techniques, bacterial cultures capable of methyl parathion degradation were obtained from sewage plants, a eutrophic pond and a eutrophic stream. *p*-Nitrophenol was observed as an intermediate metabolite in methyl parathion degradation (Chou et al., 1976). With selection and enrichment, two microorganism species were obtained from sewage and agricultural runoff. One, identified as *Ps. stutzeri*, was capable of hydrolyzing parathion. The second microorganism, identified as *Ps. aeruginosa*, utilized *p*-nitrophenol as a sole carbon and energy source. Diethyl phosphorothionic acid, also a product of the hydrolysis of parathion, was not further degraded by these organisms (Daughton and Hsieh, 1977a). In other studies, it was demonstrated that degradation of soil parathion could be accelerated if, prior to inoculation of the soil, the microorganisms were adapted by exposure to parathion (Daughton and Hsieh, 1977b).

Reduction of the nitro group of parathion was accelerated by addition of organic materials. The effect of amendments to flooded alluvial soil was in the order glucose > rice straw > algal crust > farmyard manure > unamended. Hydrolysis of parathion in flooded soil was inhibited by addition of organic materials. This was greatest with glucose and in the order glucose inhibition > rice straw > algal crust > farmyard manure (Rajaram and Sethunathan, 1975).

At 15-day intervals, parathion was applied to flooded soils. The hydrolysis product, *p*-nitrophenol, was not detected 12 days after the first addition but was detected within 6 h after the second application. Hydrolytic capability of enrichment cultures was lost after autoclaving (Sudhakar-Barik and Sethunathan, 1978a). In other studies, p-nitrophenol rapidly disappeared from flooded alluvial soil when inoculated with parathion acclimated and enriched cultures. Ring cleavage of p-nitrophenol to produce CO_2 was shown to occur. Nitrite was also formed. In uninoculated samples of soils, decomposition of p-nitrophenol was slow and nitrite and CO_2 were not formed. Hydrolysis of parathion and formation of nitrite was also shown to occur with resting cells of Ps. sp. ATCC 29353. The reaction stopped at the p-nitrophenol stage when cell-free suspensions were used (Sudhakar-Barik and Sethunathan, 1978b). A Pseudomonas sp. and a Bacillus sp., isolated from parathion-amended flooded soil, metabolized ^{14}C-p-nitrophenol and produced $^{14}CO_2$ and nitrite (Sudhakar-Barik et al., 1976).

Studies indicated that parathion sorption was almost irreversible in soils high in organic matter content. An equation was developed from the relationship between the Freundlich constant k and soil organic matter.

$$\log \frac{x}{m} = \log[10.8999+3.14(\%\ \text{organic matter})^2] + 1.04 \log c$$

(Wahid and Sethunathan, 1978)

The ability of soil to hydrolyze methyl parathion was destroyed by autoclaving of the soil. When sterilized clays were preincubated with the soil or the insecticide, hydrolytic activity of the soil was reduced (Kishh et al., 1976). Attapulgite adsorption of ethyl parathion decreased when heated above 250C. In organic media, an increase in the moisture content of the clay reduced parathion adsorption (Gerstl and Yaron, 1978). In other studies, the chemical conversion of parathion on sterile soils was studied. Conversion was affected by soil constituents--clay and organic content--and proceeded via hydrolysis of the ester bond. The presence of water seemed to block active sites of parathion decomposition. The rate of decomposition of parathion was found to be of the order kaolinite > montmorillonite > organic matter. This is inversely related to the adsorption affinity of these materials for parathion (Yaron, 1975). Other studies also showed that there was a strong correlation between parathion fixation and the amount of organic matter in the soils (Kliger and Yaron, 1975; Wahid and Sethunathan, 1978). Studies also indicated that the catalytic effect of a clay such as kaolinite on parathion hydrolysis was moisture dependent. A curve relating parathion hydrolysis and water adsorption showed four points of discontinuity. Hydrolysis was slow up to 0.8% water content; increased sharply to 2% water and leveled up to 11%. Above this, hydrolysis decreased steeply (Saltzman et al., 1976).

Parathion was applied to a citrus grove. Parathion and paraoxon concentrations were lower in soil from irrigation furrows than from dry sampling sites. Soil and dust samples from beneath citrus had high paraoxon and parathion concentrations for at least 45 days after parathion application. However, concentrations were low after a rain (Spencer et al., 1975).

In sea water, two main routes of degradation of parathion were observed: chemical and biological decomposition. Hydrolysis of parathion proceeded via dearylation and loss of p-nitrophenol. Hydrolysis via dealkylation produced desethyl parathion. The hydrolytic reactions were affected by pH and salinity. Hydrolysis to p-nitrophenol was favored by high (H^+) and (OH^-) activity. The second hydrolytic pathway was observed mainly in neutral media. With growing salinity, the degradation rate of parathion was accelerated. The rate in neutral salt water was about double that observed with distilled water. p-Nitrophenol was rapidly degraded biologically (Weber, 1976).

In a model ecosystem, parathion did not show a tendency to accumulate. Parathion, paraoxon, p-nitrophenol and five unidentified compounds were observed in water of the system. Except for fish, none of the organisms contained parathion. Paraoxon, found in the water, did not appear in fish (Yu and Sanborn, 1975).

When parathion was released to the atmosphere, air sample analyses indicated rapid photochemical conversion to paraoxon. The $t_{1/2}$ was 2 minutes under midday summer sunlight (Woodrow et al., 1978).

When diets of rats contained 2 ppm HCB or 1 ppm mirex, the microsomal fraction from their livers showed a significantly increased formation of desethyl paraoxon (Iverson, 1976).

Pretreatment of rats with piperonyl butoxide inhibited oxidative metabolism of parathion and paraoxon and permitted more time for detoxification of methyl parathion by GSH-dependent enzymes. Detoxification by these GSH-dependent enzymes appeared to be more active for methyl paraoxon than for methyl parathion. The toxicity of parathion, however, was potentiated by piperonyl butoxide. Unlike methyl parathion, ethyl parathion did not cause a significant GSH disappearance (Levine and Murphy, 1977).

Studies indicated that parathion can be degraded by irradiation and that the mechanism involves a radical and an ionic mode. The relative importance depends on the solvent used (Meallier et al., 1977a and b).

Parathion vapor was not photolyzed when exposed to UV light. However, when adsorbed to fine road-dust and then exposed to UV light, parathion was converted to paraoxon, 4-nitrophenol, and O,S-diethyl O-(4-nitrophenyl) phosphate (Moilanen and Crosby, 1974). Other studies have indicated that the formation and persistence of toxic alteration products was related to the type of adsorbing dust and the atmospheric conditions, primarily ozone, to which the dust was exposed (Spencer et al., 1978).

Equations were derived for parathion hydrolysis for neutral (N) and base (B) catalyzed hydrolysis in water.

$$\log k_N \text{ (M-sec)}^{-1} = 10.27 - 23500/4.576T$$

$$\log k_B \text{ (M-sec)}^{-1} = 13.66 - 21300/4.576T$$

The half-life for methyl parathion was calculated to be 74 days at 25C and pH 7. Above pH 3, there was no evidence of a catalyzed reaction (Mabey et al., 1976).

At pH 5 and 8, in distilled water saturated with air, methyl parathion photolysis at 313 nm produced only p-nitrophenol (Mabey et al., 1976).

PBA [3-Phenoxybenzoic acid]

Abscised and intact cotton leaves took up PBS very rapidly. On intact cotton leaves, the half-life was about 16 days. When ^{14}C-PBA was applied to excised leaves of cotton, vine, broad bean, soya bean, pea, lettuce, and tomato, a variety of polar products was formed by esterification with glucose (in cotton and other species) and with glucosylarabinose and glucosylxylose in vine leaves (More et al., 1978).

PCB (Aroclor, Clophen, KC, Kanechlor, Phenoclor) [Polychlorinated biphenyl]

Fatty tissues and blood of patients with Yasho were analyzed by GC. PCB's identified were:

pentachloro

2,3',4,4',5
2,3,3',4,4'

hexachloro

2,2',4,4',5,5'
2,2',3,4,4',5'
2,3,3',4,4',5

heptachloro

2,2',3,4,4',5,5'
2,2',3,3',4,4',5

nonachlor

2,2',3,3',4,4',5,5',6

(Kuroki and Masuda, 1977)

An attempt was made to develop a model that would describe the kinetics distribution, metabolism and excretion of 4-Cl-, 4,4'-Cl_2-, 2,2',4,5,5'-Cl_5-, and 2,2',4,4',5,5'-Cl_6-biphenyl in rats after i.v. administration. Results are summarized:

1. The model simulated Cl_5- and Cl_6-biphenyl up to 96 h.
2. The model underestimated Cl- and Cl_2-biphenyl after 48 h.
3. The liver metabolic rate constant decreased as chlorination increased.
4. Biliary clearance was about the same for each compound tested.
5. Urinary clearance decreased with increased chlorination.

(Lutz et al., 1977)

Individual chlorobiphenyls in soybean oil were administered to female dd strain mice. Feces were collected and analyzed. Identification of metabolites involved GC and MS. Results are summarized:

Biphenyl used	Fecal biphenyl metabolite(s) observed
2,2'-Cl_2	None detected.
3,3'-Cl_2	None detected.
4,4'-Cl_2	None detected.
2,2',5-Cl_3	None detected.
2,3',5-Cl_3	2,3',5-Cl_3-3-MeS; 2,3',5-Cl_3-4-MeS; 2,3',5-Cl_3-3-$MeSO_2$; 2,3',5-Cl_3-4-$MeSO_2$
2,4',5-Cl_3	2,4',5-Cl_3-3-MeS; 2,4',5-Cl_3-4-MeS; 2,4'-5-Cl_3-3-$MeSO_2$; 2,4',5-Cl_3-4-$MeSO_2$

Biphenyl used	Fecal biphenyl metabolite(s) observed
2,2',3,3'-Cl$_4$	None detected.
2,2',4,4'-Cl$_4$	2,2',4,4'-Cl$_4$-6-MeS; 2,2',4,4'-Cl$_4$-5-MeS; 2,2',4,4'-Cl$_4$-6-MeSO$_2$; 2,2',4,4'-Cl$_4$-5-MeSO$_2$
2,2',6,6'-Cl$_4$	None detected.
3,3',4,4'-Cl$_4$	None detected.
3,3',5,5'-Cl$_4$	None detected.
2,3',5,5'-Cl$_4$	2,3',5,5'-Cl$_4$-3-MeS; 2,3',5,5'-Cl$_4$-4-MeS; 2,3',5,5'-Cl$_4$-3-MeSO$_2$; 2,3',5,5'-Cl$_4$-4-MeSO$_2$
2,2',3,4,5'-Cl$_5$	2,2',3,4,5'-Cl$_5$-3'-MeS; 2,2',3,4,5'-Cl$_5$-4'-MeS; 2,2',3,4,5'-Cl$_5$-3'-MeSO$_2$; 2,2',3,4,5'-Cl$_5$-4'-MeSO$_2$
2,2',4,5,5'-Cl$_5$	2,2',4,5,5'-Cl$_5$-3'-MeS; 2,2',4,5,5'-Cl$_5$-4'-MeS; 2,2',4,5,5'-Cl$_5$-3'-MeSO$_2$; 2,2',4,5,5'-Cl$_5$-4'-MeSO$_2$
2,2',3,3',4,4'-Cl$_6$	None detected.
2,2',3,3',5,5'-Cl$_6$	None detected.
2,2',3,3',6,6'-Cl$_6$	None detected.
2,2',4,4',5,5'-Cl$_6$	None detected.
2,2',4,4',6,6'-Cl$_6$	None detected.
3,3',4,4',6,6'-Cl$_6$	None detected.
2,2',3,4,5,5'-Cl$_6$	None detected.

(Mizutami et al., 1978)

An Alkaligenes sp. and an Acinetobacter sp. were isolated which were capable of metabolizing polychlorinated biphenyls to respective chlorinated benzoic acids. Results are summarized:

Metabolite	Source biphenyl		
Monochlorobenzoic acids	2-Cl	2,2'-Cl$_2$	2,2',5-Cl$_3$
	3-Cl	2,4'-Cl$_2$	2,3',5-Cl$_3$
	4-Cl	4,4'-Cl$_2$	2,4,4'-Cl$_3$
			2,4',5-Cl$_3$
			3,4,4'-Cl$_3$
Dichlorobenzoic acids	2,3-Cl$_2$	2,2',5-Cl$_3$	2,2',3,3'-Cl$_4$
	2,4-Cl$_2$	2,3',5-Cl$_3$	
	2,5-Cl$_2$	2,4,4'-Cl$_3$	
	3,4-Cl$_2$	2,4',5-Cl$_3$	
	3,5-Cl$_2$	2',3,4-Cl$_3$	
		3,4,4'-Cl$_3$	

Metabolite	Source biphenyl	
Trichlorobenzoic acids	2,3,4-Cl_3 2,3,5-Cl_3 2,4,5-Cl_3	
Tetrachlorobenzoic acids	2,3,4,5-Cl_4	2,3,3',4,5-Cl_5 2,3,4,4',5-Cl_5

(Ballschmiter et al., 1977; Furukawa and Matsumura, 1976; Furukawa et al., 1978a).

Alcaligenes sp. metabolized 2-chlorobiphenyl to a compound identified by IR as 2-chlorobenzoic acid (Furukawa and Matsumura, 1976).

Anesthetized pigs were retrocarotidly administered 4-chlorobiphenyl in saline oil emulsion. Urine obtained 2 h later was analyzed. Mass spectrometry indicated the presence of 4'-chloro-4-hydroxybiphenyl and 4'-chloro-3,4-dihydroxybiphenyl. The monohydroxy compound was also observed in blood, kidney, and liver but not in lung, brain or heart. No diol was observed in these samples (Safe et al., 1975).

Chlorinated biphenyls were administered to pregnant rats. Following administration of 4-chlorobiphenyl-^{14}C, about 10% of fetal intestinal ^{14}C was as parent material, 50% was as the glucuronide of 4-chloro-4'-hydroxybiphenyl (Lucier et al., 1978). In other studies, adult male Sprague-Dawley rats were dosed with 4-chlorobiphenyl-^{14}C in corn oil. This was repeated for 7 days. TLC was used to isolate metabolites and GLC, electron impact MS, chemical ionization MS, NMR and IR were used to identify the metabolites. In addition to the main metabolite 4-chloro-4'-hydroxybiphenyl, another monohydroxy compound was identified as 4'-chloro-3-hydroxybiphenyl. A dihydroxy compound was identified as 4'-chloro-3,4-dihydroxybiphenyl. One other metabolite characterized, but not identified completely was believed to be either 4'-chloro-4-hydroxy-3-methoxy- or 4'-chloro-3-hydroxy-4-methoxy-biphenyl (Hass et al., 1977).

Lichens from a variety of habitats converted 4-chlorobiphenyl to 4'-chloro-4-hydroxybiphenyl. One species (*Pseudocyphellaria crocata*) produced an additional metabolite identified by GC-MS as 4-chloro-4'-methoxybiphenyl (Maass et al., 1976).

Preincubation of rat hepatic microsomes with phenobarbitone, benzo-α-pyrene, or 3-methylcholanthrene affected metabolism of 4-chlorobiphenyl quantitatively but not qualitatively. The major metabolite was 4'-chloro-4-hydroxybiphenyl and the minor metabolite was 4-chloro-3-hydroxybiphenyl (Wyndham and Safe, 1978).

Rabbit liver microsomes converted 4-chlorobiphenyl to 4'-chloro-4-hydroxy- and 4'-chloro-3,4-dihydroxy-biphenyls. Binding of an activated metabolite with microsomal protein and RNA was also indicated by these studies (Wyndham et al., 1976).

A mixed culture of microorganisms, when incubated with 4-chlorobiphenyl, produced 4-chloro-2-hydroxybiphenyl, 4-chloro-2'-hydroxybiphenyl, 4-chloro-3'-hydroxybiphenyl, and 4-chloro-4'-hydroxybiphenyl (Neu and Ballschmiter, 1977). Alkaligenes sp. and Acinetobacter sp. converted 4-chlorobiphenyl to 4-chlorobenzoic acid and 2-chlorobiphenyl to 2-chlorobenzoic acid (Ballschmiter et al., 1977; Furukawa and Matsumura, 1976; Furukawa et al., 1978a).

Aqueous suspensions of titanium dioxide with 2-, 3-, and 4-chlorobiphenyl were irradiated at 365 nm. The 3- and 4-chlorobiphenyls were not found after 30 minutes but 2-chlorobiphenyl was recovered 100% in the solution phase. Chloride ion was liberated by the irradiation (Carey et al., 1976). Photolysis of 2-chlorobiphenyl in acetonitrile produced biphenyl (Bunce, 1978).

2,2'-Dichlorobiphenyl-^{14}C was administered daily for 42 days to male and female rats. The ^{14}C-level plateaued after 36 days and 84.5% and 87.9% of the ^{14}C had been excreted by male and females, respectively. Urinary and fecal residues consisted of one monomethoxy, three monohydroxy, three dihydroxy, one trihydroxy, and a dechlorinated biphenyl. Conjugates were also present (Kamal et al., 1976a and b).

Incubation of ^{14}C-labeled 2,2-dichlorobiphenyl (2,2-DCB) with rat liver microsomes and an NADPH-generating system caused radioactivity to be tightly bound to microsomal protein. This bound ^{14}C was not extractable by organic solvents. When incubated with microsomes from PCB-treated rats, 2,2-DCB yielded three phenolic fractions (Hesse et al., 1978).

Goldfish converted 2,2'-dichlorobiphenyl to two monohydroxy derivatives, not further characterized, and other metabolites present in trace amounts and not identified (Herbst et al., 1976).

Sandworms, Nereis virens, accumulated 70% of 2,2'-dichlorobiphenyl, to which it was exposed, within 2 weeks. Elimination half-life was calculated as 3.0 weeks (Goerke and Ernst, 1977).

2,2'-Dichlorophenyl was applied to soil. About 53% was lost by volatilization in one year and 78% after 2 years. About 9% was soluble metabolites and 41% unextractable after one year. Two monohydroxy metabolites and conjugates were present (Moza et al., 1976b).

Irradiation of 2,2'-dichlorobiphenyl at 365 nm in aqueous titanium dioxide suspensions for 30 minutes liberated chloride and the parent compound disappeared (Carey et al., 1976).

The reaction of 2,2'-dichlorobiphenyl with ozone yielded a monohydroxy derivative, a nitrohydroxy derivative and unidentified material. The production of these materials could not be explained (Saravanja-Bozanic et al., 1977).

A mixed culture of microorganisms metabolized 2,4'-dichlorobiphenyl to 4-chlorobenzoic acid (Ballschmiter et al., 1977). In other studies, an Alkaligenes sp. metabolized 2,5-dichlorobiphenyl to 2,5-dichlorobenzoic acid (Furukawa and Matsumura, 1976).

Rabbits metabolized 4,4'-dichlorobiphenyl to 4,4'-dichloro-3-hydroxybiphenyl, 3,4'-dichloro-4-hydroxybiphenyl, and 4'-chloro-4-hydroxybiphenyl (Safe et al., 1976).

4,4'-Dichlorobiphenyl in corn oil was administered to adult male Sprague-Dawley rats for 6 days. TLC was used to isolate the metabolites and GC, MS and IR were used to identify these compounds. The major metabolite was identified as 3,4'-dichloro-4-hydroxybiphenyl. The minor metabolite, as 4,4'-dichloro-3-hydroxybiphenyl (Hass et al., 1977).

Male Wistar rats metabolized 4,4'-dichlorobiphenyl, administered in peanut oil, to a series of mono-, di-, and tri-hydroxybiphenyls found in urines that included the following: 4'-chloro-4-hydroxybiphenyl; 4,4'-dichloro-3-hydroxybiphenyl, 3,4'-dichloro-4-hydroxybiphenyl; 4,4'-dichloro-2,5-dihydroxybiphenyl; 4'-chloro-3-hydroxybiphenyl; 4-chloro-3,4'-dihydroxybiphenyl; 4,4'-dichloro-3,3'-dihydroxybiphenyl; 3,4'-dichloro-3',4-dihydroxybiphenyl; and two metabolites not completely identified but believed to be 2,2',5-trihydroxy- or 2,3,5-trihydroxy-4,4'-dichlorobiphenyl and the 2,3',5-trihydroxy- or 2,3,5-trihydroxy-4,4'-dichlorobiphenyl. Except the latter trihydroxy derivatives, all were also found in feces. GC-MS, NMR, and UV were used to identify the metabolites. When 4,4'-dichloro-3-hydroxybiphenyl was administered to the rats, the same compounds were formed except the 4'-chloro-4-hydroxy- and 3,4'-dichloro-4-hydroxybiphenyls (Tulp et al., 1976).

After injection of 4,4'-dichlorobiphenyl into frogs, the water in which they were kept was analyzed. Products found included: 4'-chloro-4-hydroxybiphenyl; 3,4'-dichloro-4-hydroxybiphenyl; 4,4'-dichloro-3-hydroxybiphenyl; and 4,4'-dichloro-2,5-dihydroxybiphenyl (Tulp et al., 1976).

An *Alcaligenes* sp. was isolated which, when incubated with 4,4'-dichlorobiphenyl, produced 3-chloro-2-hydroxy-6-oxo-6-(4-chlorophenyl)hexa-2,4-dienoic acid as well as 4-chlorobenzoic acid (Furukawa and Matsumura, 1976).

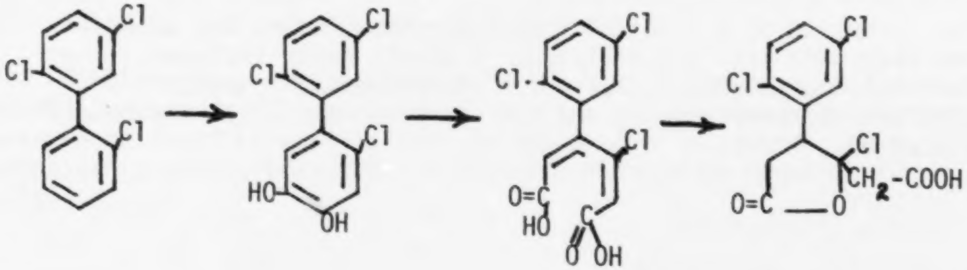
Mixed cultures of bacteria were isolated from activated sludge and incubated with 4,4'-dichlorobiphenyl. When used as a sole carbon source, 4,4'-dichlorobiphenyl yielded 4-chlorobenzoic acid and 4,4'-dichloro-2,3-dihydroxybiphenyl. Mass spectra were used to identify products (Tulp et al., 1978).

No degradation of 4,4'-dichlorobiphenyl was observed when this compound was irradiated in 20% (V/V) methanol-water solution at wavelengths corresponding to those found in nature (Lyon et al., 1975).

Rat hepatic microsomal systems converted 2,2',5-trichlorobiphenyl in about 62% yield to six metabolites, not identified. The major metabolite was characterized as a monohydroxy trichlorobiphenyl (Ghiasuddin et al., 1976). In other studies, female Wistar rats metabolized 2,2',5-trichlorobiphenyl. Two metabolites observed in urine and feces were identified as 6-hydroxy-2,2'-5-trichlorobiphenyl and 4-hydroxy-2,2',5-trichlorobiphenyl (Dequidt et al., 1976). Metabolism of 2,2',5-trichlorobiphenyl by male Sprague-Dawley rats and goldfish was almost identical *in vitro* but a large difference was observed *in vivo*. Metabolites were not identified but were believed to include monohydroxy derivatives and conjugates (Hinz and Matsumura, 1977).

A mixed culture of microorganisms obtained from soil metabolized 2,2',5-trichlorobiphenyl to 2,5-dichlorobenzoic acid (Ballschmiter et al., 1977). Similar results were obtained with *Alcaligenes* Y42 and *Acinetobacter* P6 strains (Furukawa et al., 1978b).

Mixed cultures of marine bacteria were incubated with 2,2',5-trichlorobiphenyl. Infrared analysis of diethyl ether extract of this incubation indicated the presence of a proposed lactone acid and a pathway was proposed (Carey and Harvey, 1978).



An *Alcaligenes* sp. and an *Acinetobacter* sp. metabolized 2,3,4-trichlorobiphenyl to 2,3,4-trichlorobenzoic acid (Furukawa et al., 1978a).

Female Wistar rats metabolized 2,3',5-trichlorobiphenyl. Two metabolites were observed in urine and feces but not identified (Dequidt et al., 1976).

An *Alcaligenes* sp. was isolated which, when incubated with 2,4,4'-trichlorobiphenyl, yielded 3-chloro-2-hydroxy-6-oxo-6-(2,4-dichlorophenyl)hexa-2,4-dienoic acid in addition to 2,4-dichlorobenzoic acid (Furukawa and Matsumura, 1976). In other studies, 2,4,4'-trichlorobiphenyl was metabolized by a mixed culture of soil microorganisms to 4-chlorobenzoic acid and 2,4-dichlorobenzoic acid (Ballschmiter et al., 1977).

Goldfish were exposed to 2,4',5-trichlorobiphenyl in aquaria. Metabolites were observed in the fish as well as in the aquatic environment. The metabolites were characterized but not fully identified. A monohydroxy derivative was found in the fish. Metabolites extracted from plants (*Elodea canadensis*) were identified as a monohydroxy-monomethoxy trichlorobiphenyl and a dihydroxy-monomethoxy trichlorobiphenyl. The water contained a monohydroxy-monomethoxy trichlorobiphenyl and a trihydroxy-trimethoxy trichlorobiphenyl (Herbst et al., 1978).

An *Alcaligenes* sp. converted 2,4',5-trichlorobiphenyl to 3-chloro-2-hydroxy-6-oxo-6-(2,5-dichlorophenyl)hexa-2,4-dienoic acid and 2,5-dichlorobenzoic acid (Furukawa and Matsumura, 1976). Degradation of 2,4',5-trichlorobiphenyl by sludge bacteria amounted to only 1% after 6 h (Herbst et al., 1977).

Leaves of the marsh plant *Veronica beccabunga* were treated with 2,4',5-trichlorobiphenyl-^{14}C. Six weeks later TLC showed four radioactive zones. Two metabolites were characterized as monohydroxy trichlorobiphenyls. Two other compounds were identified only as conjugates of the monohydroxy derivatives (Moza et al., 1976a).

When exposed to 2,4',5-trichlorobiphenyl, the sandworm *Nereis virens* accumulated 70% of the dose to which they were exposed (Goerke and Ernst, 1977). Feces were collected and analyzed by TLC, GC and MS. Three metabolites were observed and characterized but not fully identified: two monohydroxy and one monomethyl-monohydroxy derivative (Ernst et al., 1977).

2,4,5-Trichlorobiphenyl was metabolized by *Alcaligenes* sp. and *Acinetobacter* sp. to 2,4,5-trichlorobenzoic acid (Furukawa and Matsumura, 1976; Furukawa et al., 1978a).

A mixed culture of soil microorganisms metabolized 3,4,4'-trichlorobiphenyl to 4-chlorobenzoic acid and 3,4-dichlorobenzoic acid (Ballschmiter et al., 1977).

Isomers of tetrachlorobiphenyls were administered to mice. Biological half-times in the body are tabulated:

Biphenyl	Body half-time (day)
2,2',3,3'	0.55
2,2',6,6'	0.20
2,3,5,6	0.70
3,3',4,4'	1.7
3,3',5,5'	5.1

(Sugiura et al., 1976)

Intraperitoneal administration of 2,2',4,4'-tetrachlorobiphenyl to female dd strain mice yielded fecal metabolites identified as the 5- and 6-methylthio derivatives of this biphenyl and the corresponding sulfonyl analogs. GC and GC-MS and comparison with synthesized compounds were used to identify the metabolites (Mizutami, 1978).

Liver microsomes from an adult rhesus monkey were incubated in a NADPH-generating system with 2,2',5,5'-tetrachlorobiphenyl. These studies indicated than an active metabolite formed and was capable of binding covalently to RNA and protein in the incubation mixture. When held at 100C for 10 minutes prior to incubation, the metabolite was not formed. While addition of GSH to the incubation medium inhibited, addition of microsomal supernate increased binding of the active metabolite to macromolecules (Seymour et al., 1976).

Lactating Holstein cows were each given single oral doses of 2,2',5,5'-tetrachlorobiphenyl. Only one metabolite was found in the milk and was identified by GC and MS as 4-hydroxy-2,2',5,5'-tetrachlorobiphenyl. The same metabolite was observed in the urine in both the free and conjugated form (Gardner et al., 1976).

Female dd strain mice were administered 2,2',5,5'-tetrachlorobiphenyl in vegetable oil intraperitoneally. Electron capture GC and GC-MS were used to identify four fecal metabolites as the 3- and 4-methylthio derivatives and the 3- and 4-methylsulfonyl analogs of 2,2',5,5'-tetrachlorobiphenyl (Mio et al., 1976).

Rats were given ^{3}H-labeled 2,2',5,5'-tetrachlorobiphenyl by gastric intubation. Within 24 h, about 33% of the ^{3}H was found in the bile. The major metabolite was identified by GC and GC-MS as the 3-hydroxy derivative. Another metabolite containing about 2% of extractable radioactivity was identified as trans-3,4-dihydro-3,4-dihydroxy-2,2',5,5'-tetrachlorobiphenyl (Norback et al., 1976).

Rainbow trout were exposed to ^{14}C-labeled 2,2',5,5'-tetrachlorobiphenyl. Bile was collected and pooled at 24 h and 48 h exposures. Analyses of both were similar and indicated the presence of conjugated metabolites. These were hydrolyzed by β-glucuronidase and the TMS ether of one of the compounds matched the TMS ether of 4-hydroxy-2,2',5,5'-tetrachlorobiphenyl during gas chromatography (Melancon, Jr., and Lech, 1976). The $t_{1/2}$ found for this biphenyl in rainbow trout was 2.66 years (Guiney et al., 1977). Egg and sperm maturation enhanced elimination in adult trout with a $t_{1/2}$ = 1.76 years in females and 1.43 years in males just before spawning (Guiney and Peterson, 1978).

Mixed cultures of marine bacteria were incubated with 2,2',5,5'-tetrachlorobiphenyl. A metabolite was isolated and believed to be a lactone acid but could not be identified by GC/MS because of decomposition during gas chromatography (Carey and Harvey, 1978).

2,3,4,5-Tetrachlorobiphenyl was metabolized by Alcaligenes sp. and Acinetobacter sp. to 2,3,4,5-tetrachlorobenzoic acid (Furukawa et al., 1978a).

Rats administered 3,3',5,5'-tetrachlorobiphenyl excreted 80% in feces and 6% in urine within 42 days. After 7 days, urinary excretion of this biphenyl was negligible (Tuey and Matthews, 1977).

When goldfish were exposed to 2,2',4,4',6-pentachlorobiphenyl, there was no evidence of metabolism of this compound (Herbst et al., 1978).

In a plant-soil-water environment, total 2,2',4,4',6-pentachlorobiphenyl conversion was only 2.1%. Conversion products were not isolated for identification (Moza et al., 1976a).

The sandworm Nereis virens accumulated about 93% of the 2,2',4,4',6-pentachlorobiphenyl to which it was exposed (Goerke and Ernst, 1977). Although polar material was observed in feces, no compounds were isolated for identification (Ernst et al., 1977).

When activated sludge was incubated with 2,2',4,4',6-pentachlorobiphenyl, there was no evidence of degradation of the biphenyl (Herbst et al., 1977).

Squirrel monkeys, given 2,2',4,5,5'-pentachlorobiphenyl orally or i.v., converted a portion of this compound to the form of two hydroxylated derivatives. These compounds, found in feces, were not identified but were presumed to be the 3'- and 4'-hydroxy derivatives found in mouse feces in other studies (Holm, 1977).

2,2',4,5,5'-Pentachlorobiphenyl was given to lactating cows as an oral dose. Analysis of milk with GC and MS showed the presence of a small amount of 4-hydroxy-2,2',4',5,5'-pentachlorobiphenyl (Gardner et al., 1976).

Radiolabeled 2,2',4,5,5'-pentachlorobiphenyl was administered i.v. to adult male Sprague-Dawley rats. Chromatography indicated the presence of at least three compounds in feces. With the use of methane chemical ionization mass spectra and proton nuclear magnetic resonance spectra, three compounds were assigned the following structures: 2,5-dichloro-3-hydroxy-2',4',5'-trichlorobiphenyl; 2,5-dichloro-3,4-dihydro-3,4-dihydroxy-2',4',5'-trichlorobiphenyl; and the third compound tentatively identified as 2,5-dichloro-3,4-dihydroxy-2',4',5'-trichlorobiphenyl (Chen et al., 1976).

When 2,3,3',4,4'-pentachlorobiphenyl was administered to rats, there was no evidence of the presence of metabolites in feces, urine or tissues (Yamamoto et al., 1976).

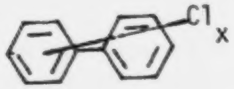
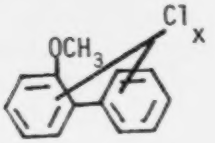
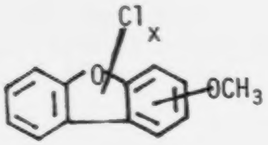
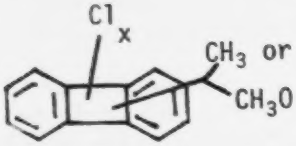
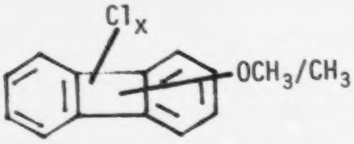
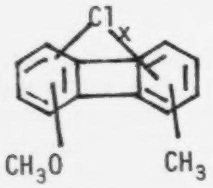
A mixed culture of microorganisms converted 2,3,3',4,5- and 2,3,4,4',5-pentachlorobiphenyl to 2,3,4,5-tetrachlorobenzoic acid (Ballschmiter et al., 1977).

Rabbits, rats and mice were administered 2,2',4,4',5,5'-hexachlorobiphenyl in peanut oil. Feces were collected and analyzed with the use of GC and MS and comparison with synthetic compounds. Feces of rats and mice contained only the 3-hydroxy hexachlorobiphenyl. Feces of rabbits contained the latter compound as well as two pentachlorobiphenyls: 2,5-dichloro-3-hydroxy-2',4',5'-trichlorobiphenyl and 2,5-dichloro-4-hydroxy-2',4',5'-trichlorobiphenyl. Although hydroxy-methoxy derivatives in the rabbit urine were indicated, none could be isolated (Sundstrom et al., 1976).

Decachlorobiphenyl was administered orally to rats and chicks. Gas chromatographic analyses of excreta and tissues showed no peaks in addition to the parent material (Alumot and Mandel, 1976).

The photolysis of 2,2',4,4',6,6'-hexachlorobiphenyl in methanol produced dechlorination products with PCB's containing from one to five chlorines. Oxygenated compounds with one or two oxygen atoms comprised the largest number of products. This and the photolysis of several other PCB's is summarized in the following table (Andersson et al., 1974).

PCB Photolysis

Product	Biphenyl used				
	2,2', 5,5'	2,2', 6,6'	2,3',4, 4',5	2,2',4, 4',5,5'	2,2',4 4',6,6'
	1-4*	0-4	2-5	2-6	2-6
	0-4	0,1,3	2-4	1-5	1-5
		0		2	1-2
 Cl x CH$_3$ or CH$_3$O		0		2-3	1-3
 Cl$_x$ OCH$_3$/CH$_3$					2-3
 Cl x CH$_3$O CH$_3$		0-1		2	

*Numbers refer to chlorine atoms in products.

Blubber from Baltic Sea seals was extracted and analyzed by GLC and MS. These analyses indicated the presence of PCB methyl sulfones containing three to seven chlorines distributed between the two rings. None were identified (Jensen and Jansson, 1976).

Mixed cultures of microorganisms metabolized Clophen A 30. 4-Chlorobenzoic acid and 2,4-dichlorobenzoic acid were identified as PCB metabolites (Ballschmiter et al., 1977). In other studies with Aroclors, during incubation with Alcaligenes sp., a yellow color was produced which was similar to that observed with degradation of catechol. Color production was in the order of Aroclor 1242 >> Aroclor 1254 > Aroclor 1260 (Furukawa and Matsumura, 1976).

Aroclors 1016 and 1242 were fed to Sherman rats. Both were metabolized and the following were found in urine: a dichloro-monohydroxy; dichloro-dihydroxy; trichloro-monohydroxy; trichloro-dihydroxy; and tetrachloro-monohydroxy. A tetrachloro-dihydroxy derivative was also obtained with Aroclor 1016. Three phenolic compounds also found in the urine may have arisen from hexachlorobenzene which was found in adipose tissue (Burse et al., 1976).

Lactating cows were given oral doses of Aroclors 1242 and 1254. Ten hydroxylated metabolites with two to four chlorines per molecule were observed with Aroclor 1242 and four hydroxylated derivatives having four or five chlorines per molecule with Aroclor 1254 (Gardner et al., 1976).

In rats, the biologic half-life of Aroclor 1254 was calculated to be 8 weeks in males and 12 weeks in females (Braunberg et al., 1976).

After Aroclor 1254 was photolyzed in an aqueous suspension of titanium dioxide at 365 nm for 30 minutes, no unreacted Aroclor could be detected. GC analysis with an electronic capture detector exhibited no peaks, indicating the absence of PCB's and other chlorinated compounds. With a flame ionization detector, a complex series of peaks was observed (Carey et al., 1976).

In vivo studies with rats indicated that PCB's orally administered were covalently bound to macromolecules in hepatocytes. The microsomal system involved in the activation required NADPH and molecular oxygen (Shimada, 1976).

Activated sludge readily degraded mono- and di- chlorobiphenyls. As the levels of chlorination increased, degradation rates decreased with persistence most notable with compounds having five or more chlorine atoms per molecule (Tucker et al., 1976). With Kanechlor 500, PCB degradation was not appreciable in the presence of synthetic sewage, neither during the aeration process nor as the result of anaerobic digestion (Kaneko et al., 1976).

Bacteria isolated from marine and estuarine environments were capable of metabolizing PCB's. These organisms are listed:

Pseudomonas sp.
Vibrio sp.
Aeromonas sp.
Micrococcus sp.
Acinetobacter sp.
Bacillus sp.
Streptomyces sp.

(Sayler et al., 1978)

PCMC [*p*-Chlorophenyl *N*-methylcarbamate]

PCMC inhibits the microbial hydrolysis of many phenylcarbamates, anilides, acetamides and thiocarbamates. This inhibitory effect exhibited a $t_{1/2}$ = 20 days with respect to chlorpropham breakdown. PCMC was converted to *p*-chlorophenol (Priest and Stephens, 1975). In aqueous solution, PCMC underwent spontaneous hydrolysis to *p*-chlorophenol. This hydrolysis preceded metabolism of the chlorophenol by *Arthrobacter* sp. to 4-chlorocatechol (Westmacott and Wright, 1975).

PCNB (Quintozene) [Pentachloronitrobenzene]

In rhesus monkeys administered PCNB in the daily diet, there was little accumulation of PCNB in fat tissue. The storage curve leveled out after 30 to 40 days. The storage plateau indicated about 2 to 3% of the administered dose. Metabolites found in rhesus monkeys after single oral dose and after chronic feeding of PCNB are summarized:

II. Pentachloroaniline
III. Pentachlorobenzene
IV. Pentachlorophenol
V. Pentachlorothioanisole
VI. Tetrachloro-bis(methylmercapto)benzene
VII. Tetrachloroaniline
VIII. Tetrachloromethylmercaptoaniline
IX. Tetrachloromethysulfinylaniline
X. Tetrachlorophenol
XI. Tetrachloromethylmercaptophenol
XII. Pentachlorothiophenol
XIII. Tetrachlorothioanisole
XIV. 1,2-dichloro-4,5-dimethoxybenzene (proposed structure)

When purified PCNB was administered to sheep, 80% of the dose was eliminated in 3 days via feces. About 5% was present as pentachloroaniline (PCA). 0.4% of the dose appeared in urine, mostly as PCA. The biological $t_{1/2}$ of PCA in fat was 1 to 3 days. Commercial preparations contained 5-10% hexachlorobenzene (HCB) as an impurity, which was the most persistent residue (Avrahami and White, 1976).

After administration of uniformly labeled ^{14}C-PCNB to a lactating goat, excreta and milk were collected and analyzed. After oral administration, PCA was observed in feces, urine and milk; PCA glucuronide in urine; and possibly a PCA sulfamate in urine. After i.v. administration, pentachlorothiobenzene glucuronide may also be present in urine (Aschbacher and Feil, 1976).

Rabbits were given PCNB orally and urine was collected for 72 h post-treatment. Two metabolites were identified as PCA and *N*-acetyl-*S*-(pentachlorophenyl)cysteine (Renner et al., 1978b).

PCNB was fed to day-old white leghorn cockerels. Analyses of tissues showed the presence of trace amounts of PCA and pentachlorophenylmethylsulfide (PCMS). Although PCNB and its metabolites did not accumulate to a major extent, the contaminants, hexachloro- and pentachlorobenzene, accumulated in adipose tissue. The half-life in adipose tissue for these two compounds was found to be 95 and 53 days, respectively (Dunn et al., 1978; Reed et al., 1977).

When PCNB was applied to onions the major metabolites were: pentachloroaniline, pentachloroanisole, pentachlorophenyl methyl sulfoxide, pentachlorothioanisole, pentachlorobenzene, pentachlorothiophenol, and pentachlorophenol. Other metabolites observed were: N-formylpentachloroaniline, tetrachloroaniline, tetrachloromethylmercaptoaniline, tetrachloronitrobenzene, tetrachlorobenzene, tetrachlorothioanisole, pentachlorophenyl methyl sulfone, and pentachlorophenylacetate (Muller et al., 1978).

In nutrient solution, peanut seedlings absorbed PCNB through the roots. Metabolism of PCNB occurred in the root and foliar tissues. Products, identified by chromatography and MS, included PCA, pentachloromethylmercaptobenzene, pentachlorophenylmethylsulfoxide, and S-pentachlorophenyl-N-malonylcysteine (Lamoureux and Rusness, 1976).

The use of PCNB in the growing of vegetables and flowers led to the presence in soils of gardens and greenhouses of PCNB, HCB and PCA. Residues of the latter were higher than that of the other two. Plants grown in these soils, especially lettuce and root vegetables, were contaminated by PCNB, HCB and PCA residues taken up from contaminated soils (Dejonckheere et al., 1976; Hafner, 1976). In other studies, PCA was formed in soil after application of PCNB. Methylthiopentachlorobenzene (MTPCB) also formed from PCNB but not from PCA. MTPCB residues disappeared more rapidly than did those of PCA (Hafner, 1978). Under anaerobic conditions in flooded and moist silty clay loam, PCNB enhanced soil respiration. TLC and GLC were used to identify degradation products, of which PCA was the major compound. Pentachlorophenol (PCP) and pentachlorothioanisole (PCTA) were also observed. More of the latter was found in moist soil than in flooded soil (Murthy and Kaufman, 1978). In other studies, the possible formation of polychloroazobenzenes from PCNB and PCA was examined. Although incubation of 3,4-dichloroaniline yielded the expected 3,3',4,4'-TCAB, no formation of azobenzenes from PCA could be found (Buser and Bosshardt, 1975).

In soil, the $t_{1/2}$ of PCNB in Columbia fine sandy loam, Sacramento clay, and Staten peaty muck were 4.7, 7.6, and 9.7 months, respectively. The major metabolite was pentachloroaniline (PCA) (Wang, 1972). Anaerobic degradation of PCNB in soil also gave rise to PCA primarily. Pentachlorothioanisole (PCTA) was also observed (Murthy and Kaufman, 1977b).

PCP [Pentachlorophenol]

^{14}C-PCP, uniformly ring-labeled, was administered to Rhesus monkeys by intubation. Peak plasma concentrations occurred 12-24 h after administration of the dose; and absorption and clearance indicated first-order kinetics. The half-life values were determined and are tabulated below:

	Half-life (h)		
	Absorption	Elimination	Excretion
Male	1.03	72.0	40.8
Female	1.81	83.5	92.4

Radioactivity in urine was accounted for by unchanged PCP (Braun and Sauerhoff, 1976).

Inhalation studies with PCP indicated that the half-life after a single inhalation exposure was 24 h (Hoben et al., 1976a). Some non-specific binding of PCP to albumin after inhalation of PCP by rats has also been demonstrated (Hoben et al., 1976b). In other studies, rats were given a single oral dose of ^{14}C-PCP. Some of the dose was excreted via feces but the primary route was the urine. $^{14}CO_2$ accounted for less than 1% of the dose. The kinetics appeared to be biphasic in males and females given 10 mg/kg and in males given 100 mg/kg but monophasic in females given 100 mg/kg. Half-life values are summarized:

	Half-life (h)			
	10 mg/kg		100 mg/kg	
	α	β	α	β
Male	17	40	13	121
Female	13	32	27	--

Autoradiography on TLC and MS was used to identify PCP urinary metabolites. Almost half the residue in urine was unchanged PCP. Tetrachlorohydroquinone (TCH) accounted for about 10%. Treatment of extracted urine with glucuronidase released PCP indicating the presence of PCP glucuronide. Plasma analyses showed the presence of PCP and its glucuronide but TCH was not detected (Braun et al., 1977).

In rats, the rapid dechlorination of PCP was mediated by hepatic microsomal enzymes and was enhanced by such inducing agents as phenobartital, 3-methylcholanthrene and TCDD. Products identified were tetrachloro-p-hydroquinone and trichloro-p-hydroquinone. These two compounds and

PCP were excreted free and in part as glucuronic acid conjugates. Similar results were also observed *in vitro* (Ahlborg, 1978; Ahlborg et al., 1978).

In vitro studies with liver slices or homogenates from goldfish, carp, rainbow trout and short necked clam did not show formation of PCP sulfate conjugation. However, *in vivo* studies with goldfish (*Carassius auratus*) showed that PCP formed a conjugate which accumulated in the bile. This was identified as pentachlorophenyl-β-glucuronide. No sulfate or other conjugate was detected (Kobayashi et al., 1976 and 1977).

Rainbow trout were exposed to ^{14}C-PCP and ^{14}C-PCA in a tank. In these static studies, the concentration factor was about 400 for PCP and 4000 for PCA in adipose tissue. In liver, PCP concentrations were higher than PCA. This was reflected in the half-life values in fat: PCP=23.7 h; PCA=23.4 days. Similar differences were observed in blood (6.2 h vs. 6.3 d), liver (9.8 h vs. 6.9 d), and muscle (6.9 h vs. 6.3 d) for PCP and PCA, respectively. Bile of PCA exposed fish contained PCP-glucuronide as did PCP exposed fish. This indicated demethylation of PCA and then conjugation (Glickman et al., 1977). In bluegill exposed to PCP, concentrations in various tissues varied from 10 to 350 times ambient concentration with the highest concentration in liver (Pruitt et al., 1977).

Young rice plants were planted in soil containing ^{14}C-PCP. About 3% of the ^{14}C was absorbed in one week. In addition to material bound to the plant and unextractable, there were conjugates (not identified) and one compound identified by TLC, GLC and MS as 2,3,4,6-tetrachlorophenol (Haque et al., 1978a).

PCP was absorbed by goldfish from water and rapidly excreted mainly as a sulfate conjugate. The biological half-life was about 10 h. Absorbed PCP was also accumulated in the gall bladder primarily as a glucuronide conjugate. In PCP-free water, this was excreted into bile at about half the rate of sulfate ester excretion into the water and urine (Kobayashi, 1978).

A spill of PCP into a lake was studied. PCP water concentration was 10 ppm 2 months after the spill and <1 ppb after 10 months. In fish, PCP residues were 2500 ppb in whole body after 2 months and <50 ppb after 10 months. Sediment and leaf litter contained 100 ppb and 6000 ppb, respectively. Analyses of lake water indicated the presence of PCP, PCA, 2,3,5,6-TCP, and 2,3,4,5-TCP. The latter probably formed by photodegradation. Observed but not quantified were trichlorophenol, chloranil, PCDD, and PCBF. The latter three were in sediment and holding pond oil samples at PPB levels. Some methylated TCP isomers were also observed (Pierce and Victor, 1977).

In laboratory studies with soils from rice fields and adjacent upland fields, PCP degradation was faster under flooded conditions. Degradation was highly correlated with the organic matter content of the soil. PCP metabolites included 2,4,6-TCP; 2,3,6-TCP; 2,3,5-TCP, 2,3,4-TCP and/or 2,4,5-TCP; 2,3,5,6-TeCP; 2,3,4,6-TeCP; 2,3,4,5-TeCP; and PCP methyl ether (Kuwatsuka and Igarashi, 1975).

Cell-free extracts of Mycobacterium sp. from soil were shown to methylate PCP. The source of the methyl group was shown to be adenosylmethionine. Other related compounds also were methylated in this system, including both 2,3,4,5-, 2,3,4,6- and 2,3,5,6-TCP, tetrachlorohydroquinone, trichlorophenols, and pentachlorothiophenol (Suzuki, 1978). Pseudomonas sp. from soil rapidly degraded ^{14}C-PCP and released $^{14}CO_2$. ^{14}C was incorporated into amino acids, TCH and tetrachlorocatechol were also observed and identified in the incubation mixture (Suzuki, 1977).

In soil, degradation rate varied with soils and the half-life varied from 10 to 70 d (Av.=30 d) in arable soils under flooded conditions; and under upland conditions, from 20 to 120 d (Av.=50 d). Compounds produced were identified as: 2,3,4,5-TeCP; 2,3,4,6-TeCP; 2,3,5,6-TeCP; 2,3,5-TCP; 2,3,6-TCP; 2,3,4- and/or 2,4,5-TCP; 2,4,6-TCP; and PCA (Kuwatsuka and Igarashi, 1975).

Anaerobic degradation in soil of ^{14}C-PCP was studied with and without cellulose amendments. No $^{14}CO_2$ was produced. In addition to the methyl ether of PCP, the 2,3,5,6- and 2,3,4,5-tetrachlorophenols and 2,3,6-trichlorophenol were also observed. ^{14}C was also distributed equally in fulvic, humic and humin fractions of soil organic matter (Murthy and Kaufman, 1977a).

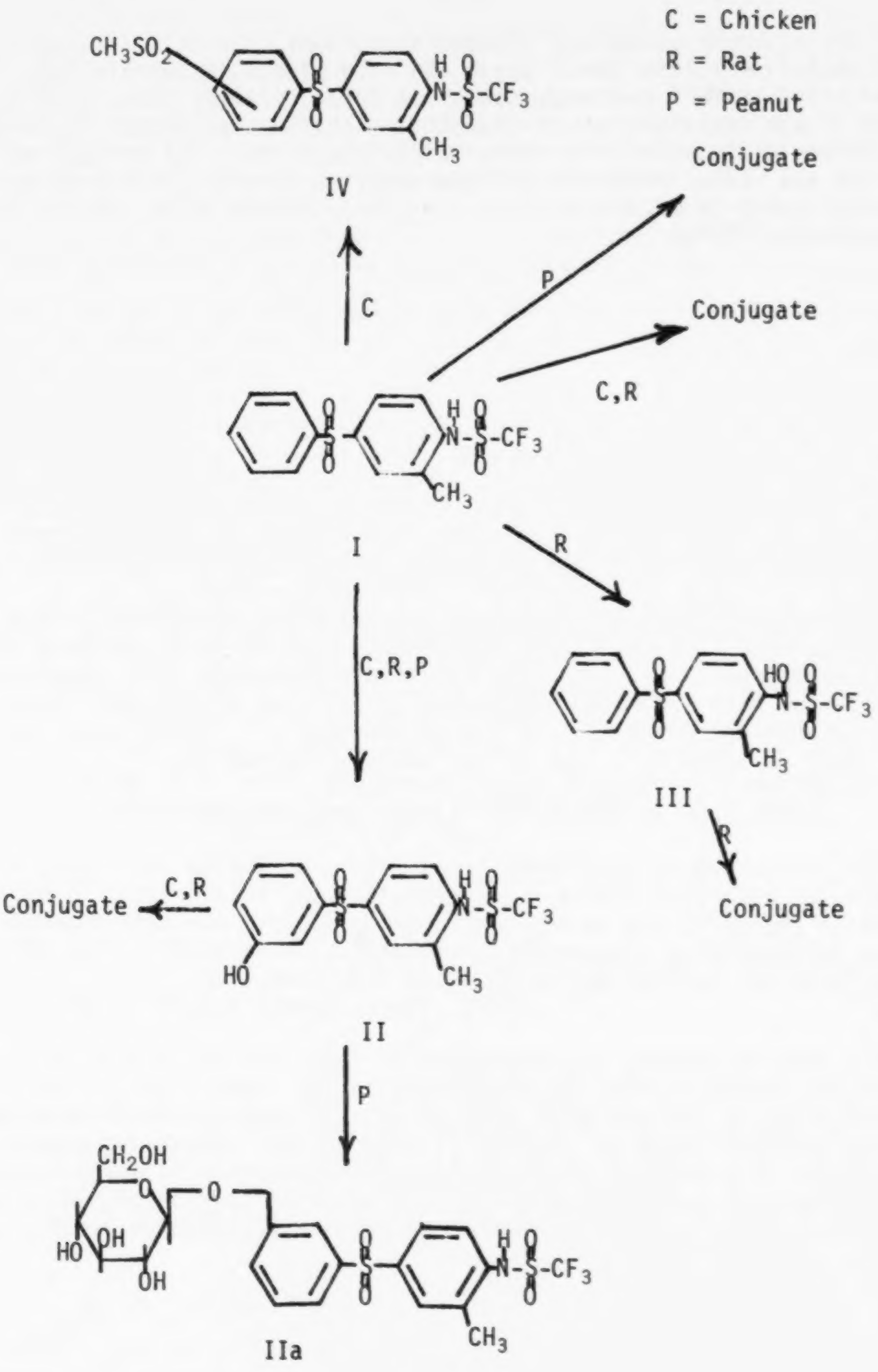
Dilute aqueous PCP solution was irradiated with sunlight or UV. The products of degradation included chlorinated phenols, tetrachlorodihydroxybenzenes, and alkyl products such as dichloromaleic acid. Irradiation of tetrachlorocatechol and tetrachlorohydroquinone also produced dichloromaleic acid. When PCP was subjected to prolonged irradiation, a colorless solution with no ether extractable volatile materials was produced. Evaporation of the water did not yield any observable polymeric residue (Wong and Crosby, 1976).

PERFLUIDONE (MBR-8251, Destun) [1,1,1-Trifluoromethyl-N-(2-methyl-4-phenylsulfonylphenyl)sulfonamide]

When ^{14}C-phenyl-perfluidone was administered as a single oral dose to a lactating cow, over a 7-day period, about 80% of the dose appeared in urine; about 20% in feces; and only a trace (about 0.1%) in milk. The only metabolite observed in the milk was identified as 4-hydroxy-perfluidone. The 3-hydroxy- and 4-hydroxy- analogs appeared in the feces. Urine contained the 4-hydroxy and 3-hydroxy- analogs and another metabolite seen only during the first 3 days post-treatment. Unchanged perfluidone was the major component excreted, accounting for 90-95% of the urinary ^{14}C and over 90% of the ^{14}C in milk (Ivie, 1975).

^{14}C-Phenyl-perfluidone was administered as a single oral dose to rats and chickens. Most of the label was excreted via feces within 48 h. Eggs produced by the laying hens within the first 96 h post-treatment contained less the 1% of the ^{14}C. The major portion of the ^{14}C excreted was in the form of unchanged perfluidone in urine and feces of both animals. Excretions by both animals contained a conjugate of I, compound III, and a conjugate of the latter. Rodent urine contained compound II and its conjugate; and chicken urine contained compound IV. Small amounts of unidentified material was also present in the excretions of both animals. MS and IR were used to identify the metabolites (Paulson et al., 1977).

Peanuts, grown in nutrient solution containing ^{14}C-phenyl-perfluidone, translocated absorbed ^{14}C to the shoots. Only unchanged perfluidone was observed in $CHCl_3$ extracts of peanut plant tissues. When excised leaves were treated with perfluidone, several metabolites were observed. Acid hydrolysis (2N HCl) of water-soluble products yielded perfluidone. With stronger conditions (6 N HCl), perfluidone and compound II were obtained. About 47% of the $CHCl_3$-soluble ^{14}C thus obtained was unidentified. Another water soluble material was treated with β-glucosidase. Analysis indicated that the radioactive product was compound II. The proposed structure for this metabolite is that of a β-glucoside such as compound IIa (Lamoureux and Stafford, 1977).


C = Chicken
R = Rat
P = Peanut
Conjugate
P
Conjugate
C,R
C
IV
I
R
C,R,P
III
R
Conjugate
Conjugate
C,R
II
P
IIa

PHENOTHIOL [S-Ethyl 4-chloro-o-tolyloxythioacetate]

In soils, under upland and flooded conditions, the half-life of phenothiol was less than 2 days. In rice plants, phenothiol was converted to MCPA and conjugated. In Sprague-Dawley rats, more than 90% of the administered ^{14}C-phenothiol label was excreted within 48 h and completely within one week, mainly via urine. The primary metabolite was MCPA. Other metabolites observed were 4-chloro-2-methylphenol and N-carboxymethyl 4-chloro-o-tolyloxyacetamide (Ohyama and Kuwatsuka, 1978a).

PHENTHOATE (Cidial, Elsan, Papthion) [O,O-Dimethyl S-(α-carboethoxybenzyl)phosphorodithioate]

^{32}P- and ^{14}C-labeled phenthoate was administered orally to female Swiss white mice. Metabolism of this compound was rapid. Within 24 h, 85 to 92% of the ^{32}P and 89 to 100% of the ^{14}C was excreted. Compounds II to VII and XIII were isolated from urine and/or feces of white mice given ^{32}P-phenthoate. Six other metabolites were observed but not identified. After administration of ^{14}C-phenthoate, in addition to compounds II to VI, compounds X, XI, XIII, and XIV were also observed. Several unidentified compounds were also present (Takade et al., 1976a).

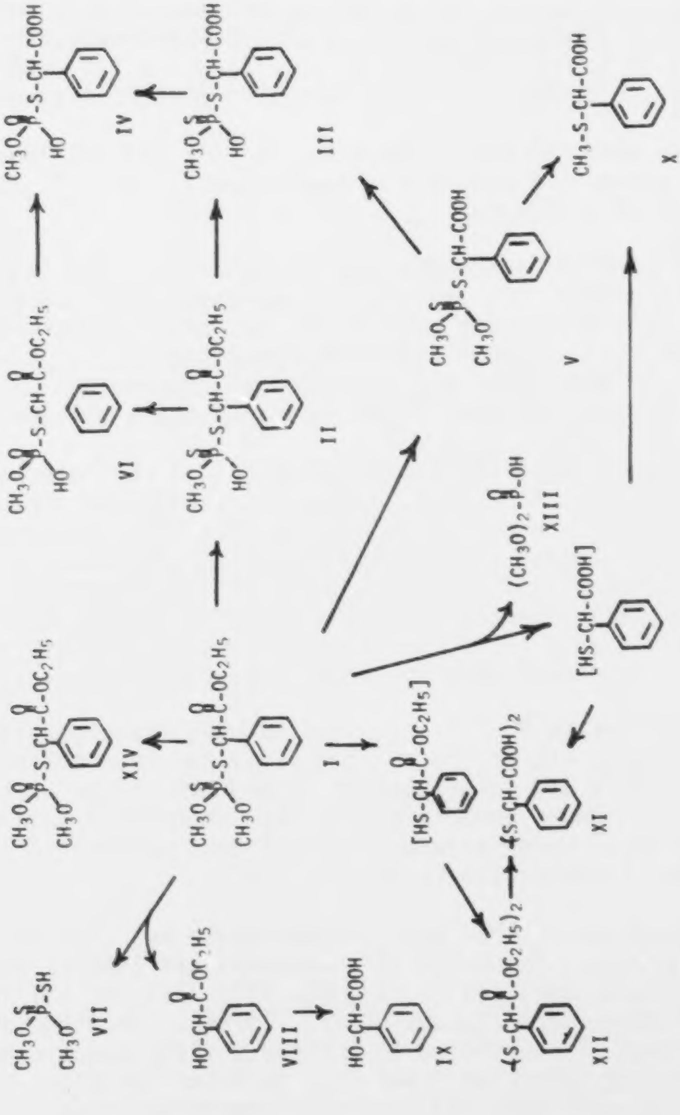
Houseflies were topically treated with ^{32}P- and ^{14}C-labeled phenthoate. Analyses showed the presence of compounds II to VIII, XI, XIII, and XIV (Takade et al., 1976a).

The major part of phenthoate applied to orange tree leaves was lost by volatilization. In addition to unchanged phenthoate, metabolites observed were phenthoate oxon (XIV), desmethyl phenthoate (II), mandelic acid (IX), bis(α-carboethoxybenzyl)disulfide (XII), O,O-dimethyl phosphorodithoic acid (VII) and O,O-dimethyl phosphorothioic acid (XIII). The same metabolites were found in orange peels (Takade et al., 1976b).

In water, phenthoate was stable at pH 6 to 8 for intervals up to 28 days with a half-life of 12 days. Compounds identified included: desmethyl phenthoate (II), desmethyl phenthoate oxon (VI), phenthoate acid (V), desmethyl phenthoate acid (III), desmethyl phenthoate oxon acid (IV), ethyl mandelate (VIII), mandelic acid (IX), bis(carboethoxybenzyl) disulfide (XII), α-methylthiophenylacetic acid (X), dimethyl phosphorodithioic acid (VII), and dimethyl phosphorothioic acid (XIII). Four other compounds were not identified (Takade et al., 1976b).

In a sandy loam soil, ^{14}C-ring-labeled phenthoate gave rise to $^{14}CO_2$. Within 73 days, 61% of the radioactivity had been collected as $^{14}CO_2$. Phenthoate acid was identified by IR and NMR as the principal metabolite in the soil. Under aerobic conditions, phenthoate acid degraded extensively to CO_2. Under anaerobic conditions, degradation was by slow first-order kinetics (Iwata et al., 1977).

Photodegradation of ^{14}C- and ^{32}P-phenthoate was studied as thin films on glass plates. About 90% of phenthoate was lost by volatilization. Compounds found included II, IX, XI, XII, XIII and XIV in addition to unchanged phenthoate (Takade et al., 1976b). In other studies, photodecomposition of phenthoate in acetone yielded benzoic acid, phenthoate oxon, phenylglyoxylic acid and CO_2; in water solution, penthoate oxon, ethyl mandelate, and α-ethoxycarbonybenzylthiol. Exposure of phenthoate to sunlight on silica gel plates yielded the same compounds as in water plus benzoic acid and carboxyphenthoate. On soil surface exposed to sunlight, benzoic acid, phenthoate oxon, carboxyphenthoate, mandelic acid and α-mercapto-phenylacetic acid were observed (Mikami et al., 1977b).


I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII
XIV

Phenylamide

Bacillus sphaericus ATCC 12123 was incubated with phenylamide herbicides and fungicides. Results are summarized in the following table (Wallnofer and Englehardt, 1971).

	Products observed	
Starting Compound	Aniline	Acid
2-Methylbenzoic acid anilide	Aniline	2-Methylbenzoic acid
2-Chlorobenzoic acid anilide	Aniline	2-Chlorobenzoic acid
2,5-Dimethylfurancarboxylic acid anilide	Aniline	2,5-Dimethylfurancarboxylic acid
2-Methyl-5,6-dihydro-4H-pyran-3-carboxylic acid anilide (Pyracarbolide)	Aniline	
2,3-Dihydro-5-carboxanilido-6-methyl-1,4-oxathiin (Carboxin)	Aniline	
α,α-Dimethyl valeric acid 4-chloroanilide (Monalide)	4-Chloroaniline	
Isopropyl *N*-phenylcarbamate (Propham)	Aniline	
N-(4-Chlorophenyl)-*N*'-methoxy-*N*'-methylurea (Monolinuron)	4-Chloroaniline	CO_2 + unknown
N-(3,4-Dichlorophenyl)-*N*'-methoxy-*N*'-methylurea (Linuron)	3,4-Dichloroaniline	CO_2 + unknown
N-(4-Bromophenyl)-*N*'-methoxy-*N*'-methylurea (Metobromuron)	4-Bromoaniline	CO_2 + unknown
N-(3-Chloro-4-bromophenyl)-*N*'-methoxy-*N*'-methylurea (Maloran)	3-Chloro-4-bromoaniline	CO_2 + unknown

PHORATE (Thimet) [O,O-Diethyl S-ethylthiomethyl phosphorodithioate]

Antibiotics were used to control microorganisms present. Phorate was incubated with the nematode *Panagrellus redivivus*. Analyses after 48 h indicated the presence of hydrolysis products, not further identified, and phorate sulfoxide and sulfone. The oxygen analog of phorate was not observed (Le Patourel and Wright, 1974a). When phorate was incubated anaerobically with *P. redivivus*, decreased hydrolysis and oxidation to the sulfoxide and sulfone were observed. In the presence of CO, only hydrolysis was inhibited (Le Patourel and Wright, 1974b). When antibiotics were not added to the medium to suppress bacteria present in the nematodes, no qualitative differences were observed. Quantitatively, greater degradation was observed (Le Patourel and Wright 1974c).

When granular phorate was applied to the soil around the bole of Douglas-firs, metabolites of phorate translocated to bark and needles and aerial parts. In the soil and in the tree, the sulfoxide and sulfone were observed in significant amounts. The corresponding oxygen analogs of the sulfoxide and sulfone were present only in trace amounts while the phorate oxygen analog was not detected (Getzin and Saunders, 1977; Saunders and Getzin, 1973).

Studies were conducted with soybean (*Glycine max* L. 'Harosoy') root homogenates. Optimal pH for phorate sulfoxidase activity was 5.5. The phorate oxon and phorate sulfone were not observed. Comparison of 25000g pellets, the most active fraction, indicated that those prepared from soybean and bean (*Phaseolus vulgaris* L. Dwarf Horticulture) were twice as active on a mg protein basis as those from barley, corn, wheat and sorghum (Krueger, 1975).

When ^{14}C-labeled phorate was applied to root nutrient of bean plants, metabolites included phorate sulfoxide, phorate sulfone, phorate thioate sulfoxide and sulfone, and a trace of phorate thioate. Other water-soluble compounds present were not identified. These metabolites were present in aphids (*Aphis fabae*) feeding on leaves of the plants as well as in the leaves (Foerster, 1974; Foerster and Galley, 1976; Galley and Foerster, 1976a and b).

Cabbage seedlings were planted in a plot and the soil was treated with granular phorate. The only metabolite observed in the cabbage was phorate sulfoxide (Krause and Van Dyk, 1975).

Carrots were grown in muck soil and treated with phorate. Residues were mostly in the peel and top 3 cm of the carrot. In addition to traces of the oxon, phorate sulfoxide and sulfone were present (Finlayson et al., 1976a).

When Eptam was applied to ^{14}C-phorate-treated soil, the amount of ^{14}C compounds in the corn greens grown in this soil increased by a factor of 1.8. In soil and corn greens after 18 days, phorate sulfoxide and sulfone were present. The corn greens also contained some phoratoxon sulfoxide (Schulz et al., 1976).

In a flooded soil system to which phorate was added, phorate sulfoxide was the major metabolite and the sulfone was present in trace amounts. When elodea was introduced, the amount of sulfone increased to 30% of the benzene extractable ^{14}C-residues (Walter-Echols and Lichtenstein, 1978a).

When ^{14}C-phorate was incubated with lake mud, 62% of the phorate was recovered unchanged after 2 weeks. Mixture of phorate-treated loam soil with lake mud further reduced the metabolism of phorate. Only phorate sulfoxide was observed in addition to the unchanged phorate. Evolution of $^{14}CO_2$ was also depressed by underlying lake mud. Elodea plants grown in the water picked up ^{14}C-compounds. Most of this was bound to plant tissue and could not be extracted (Walter-Echols and Lichtenstein, 1978b).

In a flooded loam soil treated with phorate sulfoxide, small amounts of phorate were produced. The addition of lake mud increased this reduction to the point that phorate amounted to 44% of recovered residues. This was attributed to the presence of microorganisms whose activity was enhanced by glucose (Walter-Echols and Lichtenstein, 1977).

In a microcosm apparatus, the metabolism of phorate was studied. Metabolites observed are shown in the following table.

	Phorate sulfoxide	Phorate sulfone	Phoratoxon	Phoratoxon sulfoxide	Phoratoxon sulfone
Soil	+	+			
Corn leaves	+	+	+	+	+
Roots	+	+	+	+	+

In addition to the metabolites observed, corn leaves also contained two metabolites not identified (Lichtenstein et al., 1978).

PHOSALONE [*S*-(6-Chloro-2-oxobenzoxazolin-3-yl)methyl *O,O*-diethyl phosphorodithioate]

Residues on and in Valencia oranges exhibited a half-life of 40-45 days (Westlake et al., 1972).

In a model ecosystem, phosalone was concentrated to a moderate level in fish and to lower levels in snails and algae. Several metabolites were observed but not identified (Ambrosi et al., 1978).

In soil in which phosalone had been incorporated, products observed were 3-chloro-6-benzoxazolone, phosalone oxon, and 2-amino-7-chloro-3H-phenoxazine-3-one. The half-life was 3-7 days (Ambrosi et al., 1976a).

^{14}C-Labeled phosalone was nearly immobile in leaching studies with four soils but moved somewhat in Lakeland sandy loam. When aged in aerobic and flooded soils, phosalone was not appreciably mobile but some radioactivity streaked to high R_f values. Phosalone predominated in the streak but there were unidentified materials present also (Ambrosi and Helling, 1977).

In other studies, ^{14}C-labeled phosalone was incorporated into moist and flooded Matapeake loam and Monmouth fine sandy loam. Disappearance from these soils was rapid and appeared as ^{14}C-bound soil residues. Ring cleavage accounted for only a small (ca. 8.5%) amount of the loss and volatilization was negligible. From ^{14}C-ring-labeled phosalone, 79% of ^{14}C was bound to soil and distributed in fulvic acid, humic acid, and humin. Polar metabolites were the major metabolites in flooded soils but were not identified. In addition to phosalone, three compounds were identified with MS as phosalone oxon, 6-chloro-2-benzoxazolinone and 2-amino-7-chloro-3H-phenoxazin-3-one. The half-life of phosalone was calculated to be between 3 and 7 days (Ambrosi et al., 1977a).

PHOSDRIN (Mevinphos) [Dimethyl 1-carbomethoxy-1-propen-2-yl phosphate]

Mouse liver homogenates degraded *trans*-phosdrin at a faster rate than *cis*-phosdrin. Most of the degrading activity was found in the supernatant fraction. After loss of most of the activity by dialysis, addition of reduced glutathione restored the activity fully. A product of glutathione reaction with *trans*-phosdrin was identified as methylglutathione. Dimethyl phosphate was also observed. With *cis*-phosdrin, *cis*-desmethyl phosdrin was observed (Morello et al., 1968).

PHOSMET (Imidan) [O,O-Dimethyl S-(phthalimidomethyl)phosphorodithionate]

In embryonic tissue, phosmet (I) was degraded to water-soluble derivatives of phosphoric acid and N-hydroxymethylphthalimide (II) by hydrolysis. When compound II was orally administered to pregnant rats, only phthalimide was obtained from the fetuses. The biological half-life of phthalimide was calculated to be 80 to 90 minutes. There was an indication of the formation of phthalamic acid but this was not conclusive (Ackermann et al., 1976 and 1978).

PHOSPHAMIDON (Dimecron) [*O*-3-(2-Chloro-*N*,*N*-diethylcrotonamide) *O*,*O*-dimethyl phosphate]

Adsorption of dimecron was apparently not a homogeneous chemical reaction that yielded to simple laws of kinetics and did not yield any relationship characteristic of a first, second or higher order. After an initial increase, adsorption of dimecron approached equilibrium on H-montmorillonite at 24 h and on Na- or Ca-montmorillonite at 27 h (Singhal and Singh, 1978).

PHOXIM (Bay 77488, glyoxylonitrile phenyl oxime O,O-diethyl phosphorothioate, Ethyl phoxim) [O,O-Diethyl O-α-cyanobenzaldoxime phosphorothioate]

METHYL PHOXIM (Bay SRA 7660) [O,O-Dimethyl O-α-cyanobenzaldoxime phosphorothioate]

When labeled phoxim was applied to wheat, the oxon analog and the S-isomer were observed in addition to unextractable radioactivity (Mason and Meloan, 1976).

PHTHALATES

DBP [Di-n-Butylphthalate]

DEHP [Di-(2-ethylhexyl)phthalate]

Fathead minnows, exposed to DEHP, converted this material to mono-2-ethylhexyl phthalate (MEHP) and a glucose conjugate. The same metabolites were observed in rainbow trout. Liver microsomes converted DEHP and DBP to the mono esters and two polar metabolites. In sediment, after hydrolysis to MEHP, decarboxylation and ring cleavage occurred (Melancon et al., 1978).

Studies with *Pseudomonas testosteroni* NH 1000 indicated that this organism metabolized phthalate through 4-hydroxyphthalate, *m*-hydroxybenzoate, protocatecuate and α-hydroxy-γ-carboxymuconic semialdehyde (Nakazawa and Hayashi, 1978).

PICLORAM [4-Amino-3,5,6-trichloropicolinic acid]

An acetone solution of labeled picloram was applied to leaflets of vinal (Prosopis ruscifolia Gris.) and Diplotaxis tinuifolia (L.). Forty-eight hours after treatment, the leaves were removed and analyzed. A conjugate of picloram vinal was isolated but not completely characterized. A picloram derivative was also observed, but not identified, in Diplotaxis tinuifolia (L.) (Maroder and Prego, 1971).

In laboratory studies, picloram movement decreased as soil organic matter increased (MacDonald et al., 1976). In other studies, it was noted that picloram degradation, as measured by $^{14}CO_2$ formation, decreased as water content decreased (Guenzi and Beard, 1976).

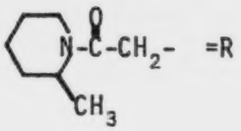
Adsorbing affinity of picloram decreased in the order Cu (II) > Fe (III) > Al (III) > Zn (II) > Ca (II). Picloram formed the stable bis-copper-4-amino-3,5,6-trichloropicolinato chelate (Arnold, 1974).

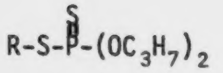
PIPERONYLIC ACID

A *Pseudomonas* sp. (*Ps*. PP-2) was incubated with piperonylic acid. The results of the study indicated that metabolism occurred via methylenedioxy ring cleavage to vanillate and then to protocatechuate after demethylation of vanillate (Vasavada and Forney, 1975).

PIPEROPHOS (C 19490, Avirosan) [*O,O*-Dipropyl-*S*-(2-methylpiperidinocarbonylmethyl)phosphorodithioate]

Greenhouse studies were used to determine the fate of piperophos in paddy rice after application to the water. At rice maturity, leaves and soil were analyzed. The observed differences were in the quantitative patterns. The metabolites appearing as neutral, nonpolar materials included the oxon (II), and 1-methylsulfinyl- (III) and 1-methylsulfonyl (IV) analogs of *N*-acetyl-2-methyl piperidine. In addition to these, 2-methylpiperidinoacetylsulfonic acid (V) and 2-methyl-1-oxalopiperidine (VI) were also identified. Hydrolysis of other plant material yielded 2-methylpiperidine (VII) (Mayer and Laanio, 1978).

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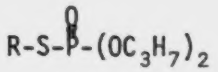
I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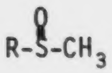
II


$R\text{-}\overset{O}{\overset{\|}{S}}\text{-}CH_3$

III

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PIRIMICARB [N,N-Dimethyl 2-dimethylamino-5,6-dimethylpyrimidin-4-ylcarbamate]

Hens and goats were fed 2-^{14}C-pirimicarb. In both species, the major metabolites were the N-demethyl, N,N-didemethyl, and N,N-dimethyl-4,5-dimethyl-6-hydroxypyrimidine. Other metabolites observed included the N,N-didemethyl and N-demethyl analogs of pirimicarb as well as the N-formyl N-methyl analog. Other polar metabolites were present. In hen muscle, hydrolysis of these gave hydroxypyrimidines (Hemingway et al., 1978).

PROMECARB (Carbamult, Minacide) [m-Cym-5-yl N-methylcarbamate]

[5-^{14}C-]Promecarb was administered orally to male Sprague-Dawley rats. Within 4 days, about 88% of the dose was eliminated in the urine. In addition to isothymol, there were unidentified metabolites. Hydrolysis with glucuronidase indicated the conjugation of isothymol with glucuronic acid. Other conjugates present were not identified (Knowles and Johannsen, 1976).

Promecarb was applied to soil and then corn seedlings were planted. Analyses of stem and leaves of the plants indicated the presence of isothymol and four unidentified metabolites as early as 15 days after application (Johannsen and Knowles, 1977).

PROPACHLOR [2-Chloro-N-isopropylacetanilide]

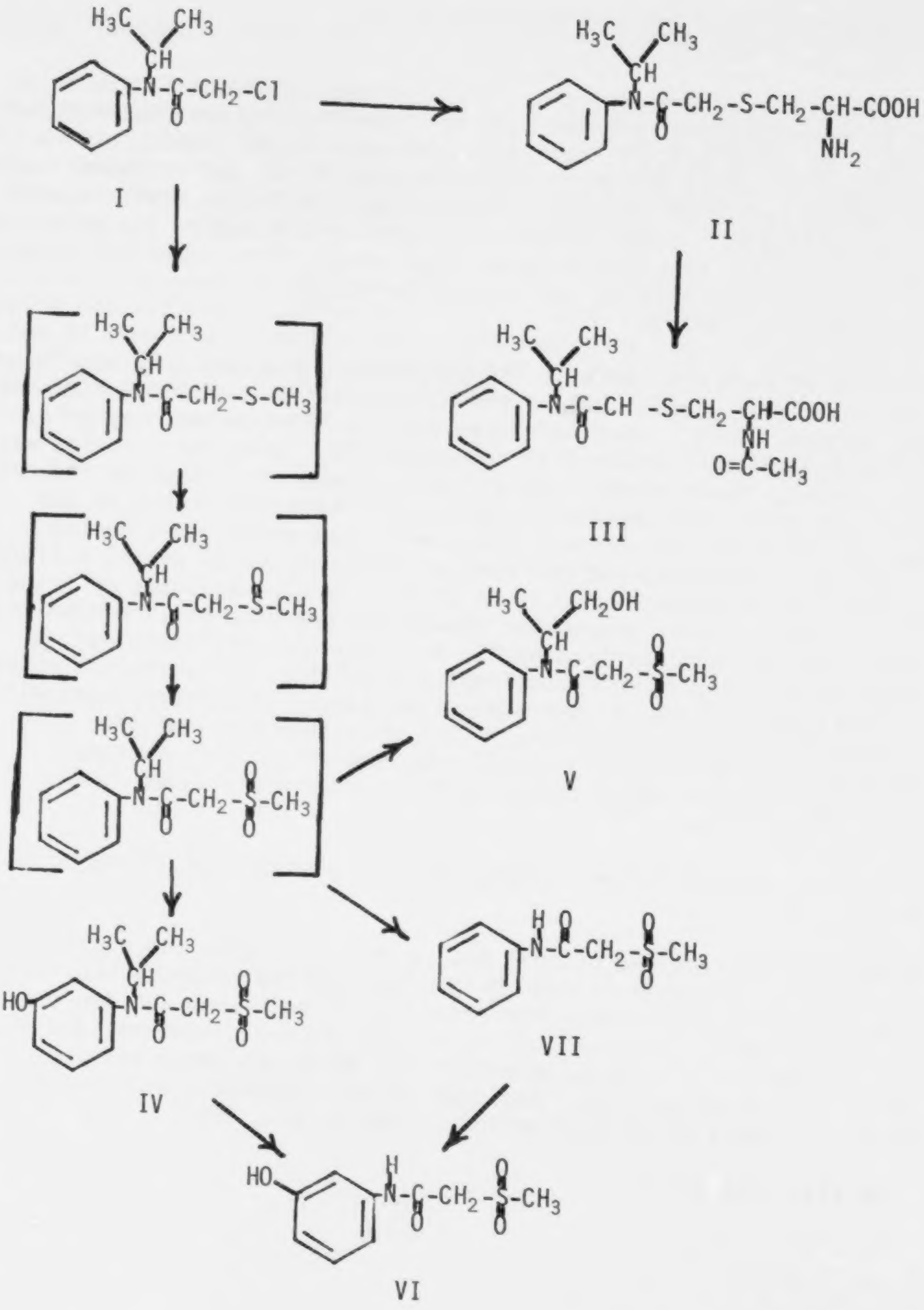
Rats administered propachlor excreted the mercapturic acid via urine. Two other metabolites present were not identified (Lamoureux and Davison, 1975). In other studies, rats and sheep were given propachlor orally. Urine was collected and analyzed. Compounds V, VI and VII were isolated and identified in addition to the cysteine (II) and mercapturic acid (III) conjugates. Compounds IV and V were also found in glucuronidase hydrolysate of a fraction obtained from sheep urine. Administration of the cysteine conjugate to rats showed formation of compounds V and VI (Bakke et al., 1976a).

In urine of rats treated with ^{14}C-propachlor, the mercapturic acid of propachlor formed about 34% of the radioactivity in urine (Lamoureux and Davison, 1975). When rats were fed the ^{35}S-labeled conjugate, the methylsulfonyl metabolites contained ^{35}S. When the cysteine was ^{14}C-labeled, these metabolites did not contain ^{14}C. Studies indicated that propachlor was secreted in bile as glutathione, cysteine and mercapturic acid conjugates. These were then metabolized in the intestine, reabsorbed and excreted as glucuronides of methyl sulfonyl metabolites of propachlor (Larsen et al., 1978). Analyses of urine of rats administered propachlor showed the presence of 11 metabolites, identified or characterized by MS, as: 2-S-(N-acetylcysteinyl)-N-isopropylanilide; 2-(methylsulfonyl)acetanilide; 4'-hydroxy-2-(methylsulfonyl)acetanilide; 4'-hydroxyacetanilide; N-(1-hydroxyisopropyl)-2-(methylsulfonyl)acetanilide; N-(1-hydroxyisopropyl)aniline; 4'-hydroxy-2-(methylsulfonyl)acetanilide; and either N-(1-hydroxyisopropyl)acetanilide or 2-hydroxy N-isopropylacetanilide (Bakke et al., 1977b).

In plants, propachlor was conjugated with glutathione (Shimabukuro et al., 1977).

Propachlor was applied to soil and to onions as pre- and post-emergence treatments. Residues of free N-isopropylaniline or propachlor were not present in the onions when harvested nor in soil when sampled one year after treatment. Analyses of the onions and soil, however, did show the presence of a conjugated metabolite which was shown after hydrolysis to be N-isopropylaniline. Residues of this conjugate were present as much as 2 years after application (Frank et al., 1977).

(See also alachlor.)


I
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VII

PROPANIL [3',4'-Dichloropropionanilide]

3,4-Dichloroaniline (DCA) formed when propanil was added to algal cultures during growth. Experiments showed that some non-axenic algal cultures were very active in DCA formation and that the bacterial contaminants were also active when free of algae. In these studies, the non-axeneic (*Nostoc entophytum* and the axenic *Tolypothrix tenius* were active in DCA production (Wright et al., 1977).

When used in flooded rice culture, propanil applied as a foliar spray dissipated within 24 h after flooding of the rice. DCA concentration in the flood waters corresponded to the decrease in propanil (Deuel, 1975; Deuel, Jr., et al., 1977).

Red Rice (*Oryza sativa* L.) seedlings were the source of an aryl amidase. Studies showed that this enzyme was able to hydrolyze propanil, as well as some analogs. Although active between pH 7.4 to 8.7, the optimum was 8.2. Calculations showed the $K_m = 2.5\times10^{-5}$ and that the activity was in the order propanil >> 3'-Cl > propionanilide > 4'-Cl ≥ 3',5'-dichloro > 2'-Cl (Hoagland, 1978).

Using rice leaves, a solubilized and purified aryl acylamidase was obtained which hydrolyzed propanil (Tsai, 1974).

PROPAPHOS (Kayaphos) [*O*,*O*-Di-*n*-propyl *O*-(4-methylthiophenyl)phosphate]

Propaphos was applied to seedling boxes in which rice plants were grown and then transplanted to paddy fields. Propaphos was not detected in the paddy soil. Analysis of rice plants, however, indicated the presence of propaphos and its oxidataive metabolites, the sulfoxide and sulfone analogs (Asaka et al., 1978).

PROPOXUR (Baygon, Bayer 39007) [2-Isopropoxyphenyl N-methylcarbamate]

S-BAYGON [2-Isopropoxyphenyl N-methyl N-(o-toluenesulfenyl)carbamate]

SULFENYL-PROPOXUR [2-Isopropoxyphenyl N-methyl-N-(2-methyl-4-t-butylphenylsulfenyl)carbamate]

Sulfenyl-propoxur was metabolized by houseflies and bees to the parent compound propoxur (Mallipudi, 1978).

S-Baygon was taken up by cowpea (*Vigna sinensis* Endlicher) plants from nutrient solution. When plant tissues were analyzed by TLC, most of the residue consisted of baygon.

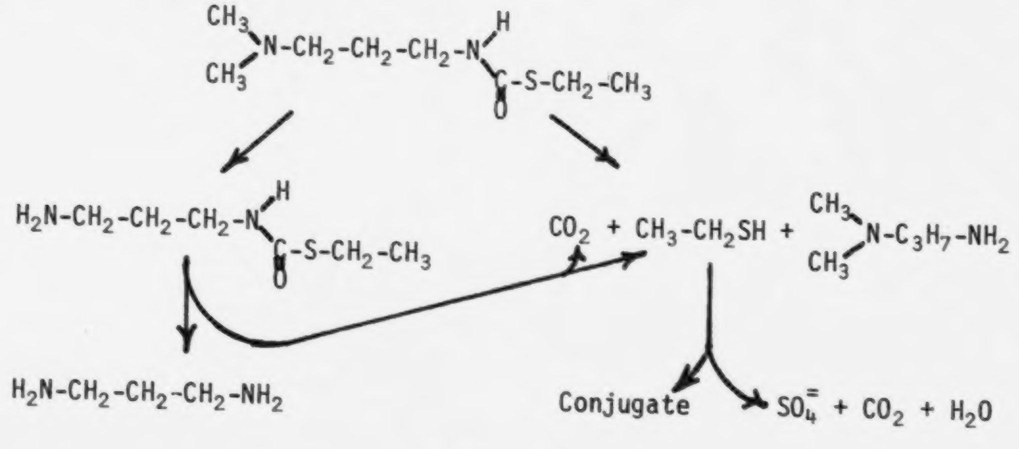
PROTHIOCARB (Previcur, SN 41 703) [*N*-(3-Dimethylaminopropyl)-*S*-ethylthiolcarbamic acid hydrochloride]

The fungicide prothiocarb apparently acts through two mechanisms. In one case, the active agent was apparently ethyl mercaptan released from prothiocarb. Toxicity would result from conversion to *L*-ethionine, an L-methionine antimetabolite (Sijpesteijn et al., 1974; Kerkenaar and Sijpesteijn, 1977).

When applied to tomato plants, prothiocarb was hydrolyzed to produce *N*,*N*-dimethylpropane-1,3-diamine primarily. Other compounds observed in tomato plants grown hydroponically were identified as bis-(3-dimethylaminopropyl)urea and 1-methyltetrahydro-1,3-diazin-2-one. A conjugate of *N*,*N*-dimethylpropane-1,3-diamine was also observed. Another compound was believed to be *N*-demethylprothiocarb but was not fully identified (Iwan et al., 1977).

In alkaline soil, prothiocarb half-life was 59 days; in acidic soil, 144 days. In addition to CO_2, the following products were formed: *N*,*N*-dimethylpropane-1,3-diamine; 1-methyltetrahydro-1,3-diazin-2-one; *N*-(3-methylaminopropyl)thiocarbamic acid *S*-methyl ester; diethyl disulfide; and ethyl mercaptan (Iwan et al., 1977).

In non-sterilized soil, decomposition of ^{14}C-propyl-labeled prothiocarb began almost immediately and about half the label appeared as $^{14}CO_2$ within 115 days. Three other degradation products were observed but only one was identified as 3-amino-1-dimethylaminopropane. A second compound was believed to be the demethylated prothiocarb. In studies with field beans and soybeans, no metabolites were observed in the plants (Iwan and Goller, 1974b).



(CH3)2N-CH2-CH2-CH2-NH-C(=O)-S-CH2-CH3
H2N-CH2-CH2-CH2-NH-C(=O)-S-CH2-CH3
CO2 + CH3-CH2SH + (CH3)2N-C3H7-NH2
H2N-CH2-CH2-CH2-NH2
Conjugate
SO4= + CO2 + H2O

PSC [2,2-Dimethyl-2,3-dihydrobenzofuran-7-yl N-dimethoxyphosphinothioyl N-methylcarbamate]

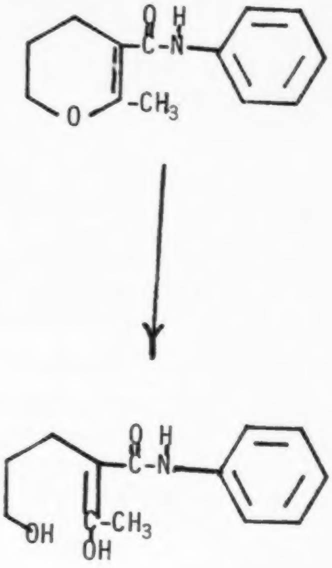
Female white rats and mice were administered 100 mg/kg ^{14}C-PSC by stomach tube. The major excretion route was via urine. Less than 1% of the urinary metabolites was extractable into $CHCl_3$, indicating conjugation. After mild acid hydrolysis, the metabolites were extractable and identified as carbofuran phenol, 3-ketocarbofuran phenol, 3-hydroxycarbofuran phenol, 3-ketocarbofuran, and 3-hydroxycarbofuran. Two metabolites were not identified. Fecal material contained the same metabolites, except 3-ketocarbofuran, as was found in urine. All fecal metabolites were obtained after mild acid treatment. After administration of ^{32}P-PSC to rats and mice, up to 70% of the dose was excreted via urine. Five ^{32}P-metabolites were observed. Of these one was identified as diemthyl N-methylphosphoramide. 3-Ketocarbofuran may have formed from the 3-hydroxy analog (Krieger et al., 1976a).

When [$^{14}CH_3$-N]PSC was administered topically to female houseflies, it was rapidly absorbed. After 4h, flies were analyzed. The rinse contained, in addition to PSC, 3-hydroxycarbofuran and N-hydroxymethylcarbofuran as conjugates and one unidentified compound. The fly extract contained dimethoxyphoshpinothioyl carbofuran and carbofuran free and 3-ketocarbofuran, 3-hydroxycarbofuran, N-hydroxymethylcarbofuran and an unidentified compound as conjugates (Krieger et al., 1976a).

Red kidney beans (*Phaseolus vulgaris*) were germinated and treated during bifolate stage with [^{14}C-ring]PSC. Bean plants analyzed 6 days after treatment contained carbofuran phenol, 3-hydroxycarbofuran phenol, carbofuran, 3-keto- and 3-hydroxy-carbofuran, and two unidentified metabolites (Krieger et al., 1976b).

PYRACARBOLID [2-Methyl-5,6-dihydro-4H-pyran-3-carboxanilide]

Pyracarbolid was applied to the leaves of summer wheat when at the past flowering growth stage. After 28 days, 26% of the applied radioactivity was still present on the leaf surfaces. TLC indicated the presence of pyracarbolid and three metabolites. The major metabolite was identified as 2-hydroxy-3-carboxanilide-6-hydroxyhex-2-ene (II) (Oeser et al., 1974).

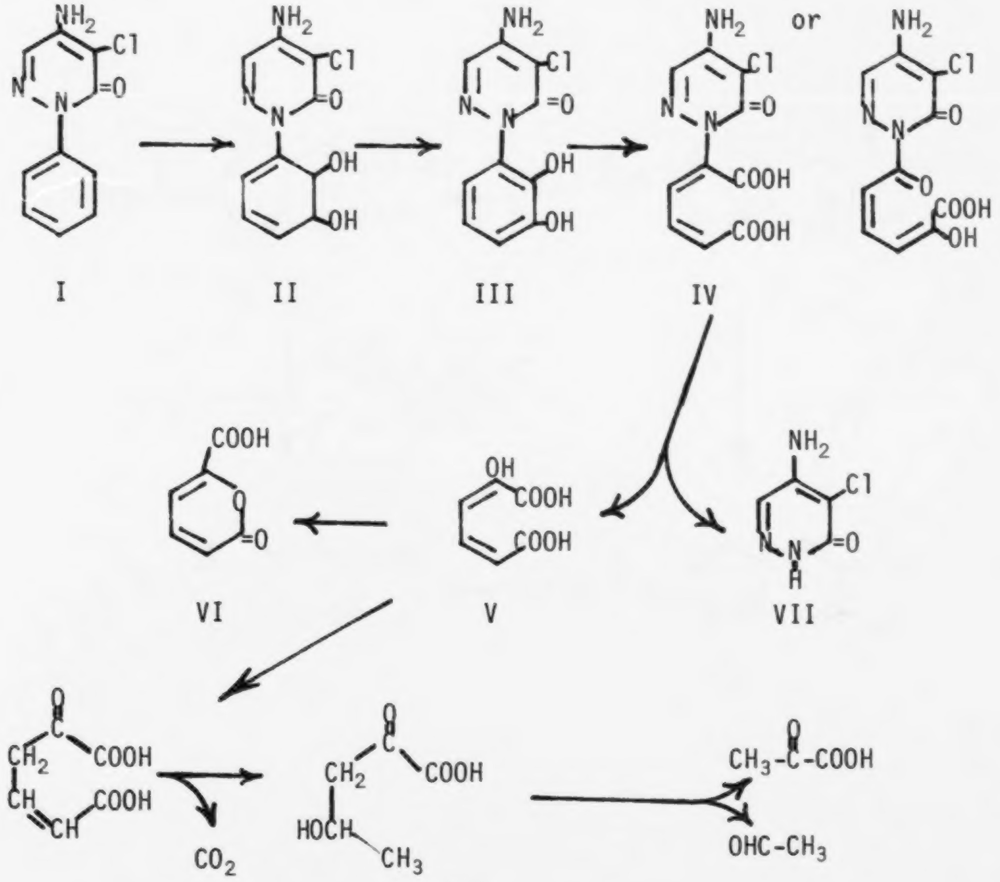


PYRAMIN (Chloridazon, pyrazon, pyrazone) [5-Amino-4-chloro-2-phenyl-3(2H)-pyridazinone]

Intact seedlings and leaf discs of red beets (Beta vulgaris L. var. Detroit Dark Red) were exposed to pyramin. Conjugation with glucose was apparently dependent on carbohydrate status. The N-glucoside formation was greater in light than in dark (Stephenson et al., 1971).

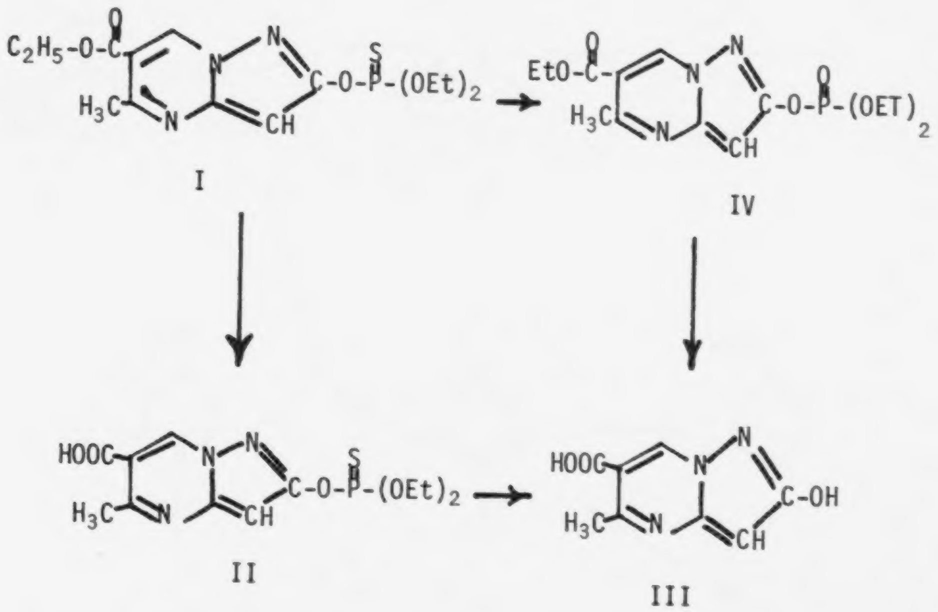
Bacteria isolated from soil were capable of degrading pyramin to produce the dephenylated heterocycle VII. Other metabolites isolated from these studies and from cell-free studies were identified as compounds II, III, and VI (Eberspacher et al., 1976; Sauber et al., 1976). Other studies were conducted with bacteria found in samples of soil from Kenya. These bacteria only utilized the benzene portion of pyramin (Lingens et al., 1977).

In a model ecosystem, about 34% of added pyrazon was degraded within 32 days. Six metabolites were observed but only one, dephenylated pyrazon (VII), was identified (Yu et al., 1975a).



PYRAZOPHOS [*O*,*O*-Diethyl *O*-(5-methyl-6-ethoxycarbonyl pyrazolo[1,5-a]pyrimidin-2-yl)phosphorothioate]

When greenhouse cucumbers were treated with pyrazophos, analyses 14 days later consisted of unchanged pyrazophos (97%) and 2-hydroxy-5-methyl-6-ethoxycarbonylpyrazolo[1,5-a]pyrimidine (II), probably as the glucoside. Twenty-one days after treatment of apples, residues consisted of unchanged pyrazophos only. On wheat leaves, greater metabolism of pyrazophos was observed. Nineteen days post application, residues were about evenly divided between unchanged pyrazophos and metabolites. The primary metabolite was not pyrazophos oxon. Compound IV was thought to be present in one wheat sample. Studies were also conducted with white rats. Single doses were administered and largely excreted within one day. Tissue residues were less than 0.05 ppm after 12 days. When repeated doses were administered (10x2 mg/day), liver residues contained compound II plus compound III. Muscle residues were less than 0.01 ppm. Analyses of the urine from rats given 10 daily doses were conducted. Compounds II and III were present, probably conjugated as sulfate or glucuronide conjugates (Gorbach et al., 1974). Fungi (*P. oryzae*) also degraded pyrazophos to compound II (De Waard, 1972).



PYRETHRINS

In mouse liver microsomal systems, primary alcohol esters of trans-substituted cyclopropanecarboxylic acids were metabolized most rapidly. Hydrolysis was the major component of the metabolic rate. The cis-analogs were hydrolyzed only slowly but were oxidized rapidly (Soderlund and Casida, 1977).

ALLETHRIN [3-Allyl-2-methyl-4-oxocyclopent-2-enyl chrysanthemate]

When allethrin was applied topically to houseflies, chromatography indicated the presence of allethrolone and chrysanthemic acid in addition to allethrin and three unidentified compounds (Hayashi et al., 1968).

CYPERMETHRIN (NRDC) [(±)-α-Cyano-3-phenoxybenzyl (±)-*cis*,*trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate]

(NRDC 159 = *trans*-cypermethrin)
(NRDC 160 = *cis*-cypermethrin)

When administered to rats and mice, a large part of *trans*-cypermethrin was eliminated in urine in 24 h. Under similar conditions, 80% of administered 3-phenoxybenzoic acid was eliminated. When *cis*-cypermethrin was administered, more was excreted via feces. The major urinary metabolite in mice, from *trans*-cypermethrin and 3-phenoxybenzoic acid, was identified with the aid of MS and NMR as *N*-(3-phenoxybenzoyl)taurine. A minor metabolite was identified as the sulfate of 3-(4-hydroxyphenoxy)benzoic acid. The taurine conjugate was not found in the rat urine (Hutson and Casida, 1978). In rats, the major metabolite was the sulfate conjugate of 3-(4-hydroxyphenoxy)benzoic acid (Crawford et al., 1978).

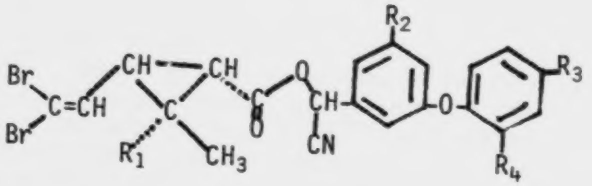
Mouse liver microsomal + NADPH preparations hydroxylated *trans*- and *cis*-cypermethrin at the *t*- and *c*-methyl groups and the 4' and 5 positions. Hydroxylation at the 5 position of *trans*-cypermethrin was detected only with microsomes treated with tetraethyl pyrophosphate to inhibit esterase activity (Shono and Casida, 1978).

Cypermethrin degradation in soil was rapid and the *trans* isomer degraded more rapidly than the *cis* isomer. Thirty to 60% of cypermethrin applied was converted to $^{14}CO_2$. Hydrolysis of the ester was the primary pathway and produced the carboxylic acid plus 3-phenoxybenzyl alcohol or 3-phenoxybenzaldehyde cyanohydrin. Both of the latter compounds were converted to 3-phenoxybenzoic acid. Another pathway produced the 3-(4-hydroxyphenoxy)benzyl ester which was in turn hydrolyzed (Kaufman et al., 1978a and c).

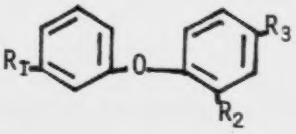
The degradation rate of *trans*-cypermethrin and *cis*-cypermethrin was most rapid on sandy clay and sandy loam. About 50% of NRDC 159 and NRDC 160 applied to the soils decomposed in 2 weeks and 4 weeks, respectively. Six degradation products were observed in soil: the 3-(4-hydroxyphenoxy)benzyl ester; 3-(4-hydroxyphenoxy)benzoic acid; 3-phenoxybenzoic acid; and (±)-*cis*- and (±)-*trans*-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylic acid. Carbon dioxide was also observed (Roberts and Standen, 1977a).

DECAMETHRIN (Decis, NRDC 161) [(S)-α-Cyano-3-phenoxybenzyl (1R,3R)-*cis*-3-(2,2-dibromovinyl)-2,2-dimethylcyclopropanecarboxylate]

After administration of decamethrin (I) to rats, the following metabolites were observed in excreta in addition to thiocyanate and 2-iminothiazolidine-4-carboxylic acid:

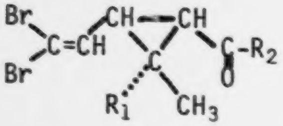


	R_1	R_2	R_3	R_4
I	CH_3	H	H	H
II	CH_2OH	H	H	H
III	CH_3	OH	H	H
IV	CH_3	H	OH	H
V	CH_3	H	H	OH



	R_1	R_2	R_3
VI	COOH	H	H
VII	$\overset{O}{\|\|}$ C-OGluc	H	H
VIII	$\overset{O}{\|\|}$ C-Glycine	H	H
IX	COOH	H	OH

	R_1	R_2	R_3
X	$\overset{O}{C}$-OGluc	H	OH
XI	COOH	H	OSO_3H
XII	COOH	OSO_3H	H



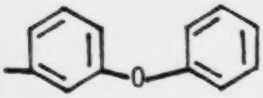
	R_1	R_2
XIII	CH_3	Glycine
XIV	CH_3	O-Gluc
XV	CH_3	OH
XVI	CH_2OH	OH
XVII	CH_2OH	O-Gluc

(Ruzo et al., 1977b and 1978).

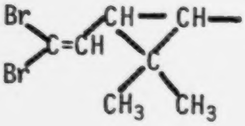
Mouse liver microsomal preparation plus NADPH hydroxylated cis-decamethrin at the c- and t-methyl groups as well as the 4' and 5 positions (Shono and Casida, 1978).

Photolysis of decamethrin at λ>290 nm in various solvents proceeded via ester cleavage, cis-trans isomerization and bromine loss. Photoproducts identified, in addition to isomers, are tabulated.

R_1 =



R_2 =

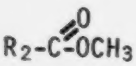


di-debrominated decamethrin

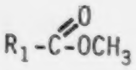
two monodebrominated decamethrins

$(CH_3O)_2-CH-R_1$

R_2-COOH



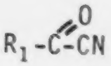
$R_2-\overset{O}{C}-OCH_3$ (2 isomers)



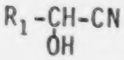
$$R_1-C(=O)-OCH_3$$

R_1-COOH

R_1-CHO

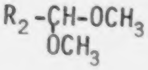


$$R_1-C(=O)-CN$$

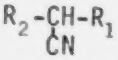


$$R_1-CH(OH)-CN$$

R_2-CHO

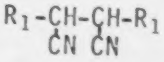


$$R_2-CH(OCH_3)-OCH_3$$



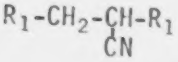
$$R_2-CH(CN)-R_1$$

R_1-CH_2CN

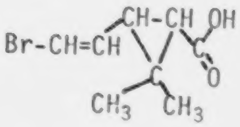


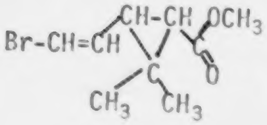
$$R_1-CH(CN)-CH(CN)-R_1$$

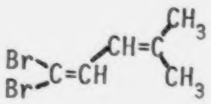
$R_1-CH_2-CH_2-R_1$



$$R_1-CH_2-CH(CN)-R_1$$



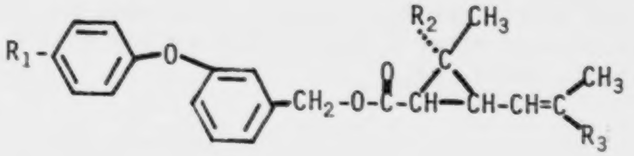


R_2-H or 

(Ruzo et al., 1977a)

(+)-cis-FENOTHRIN [3-Phenoxybenzyl (+)-cis-chrysanthemate]

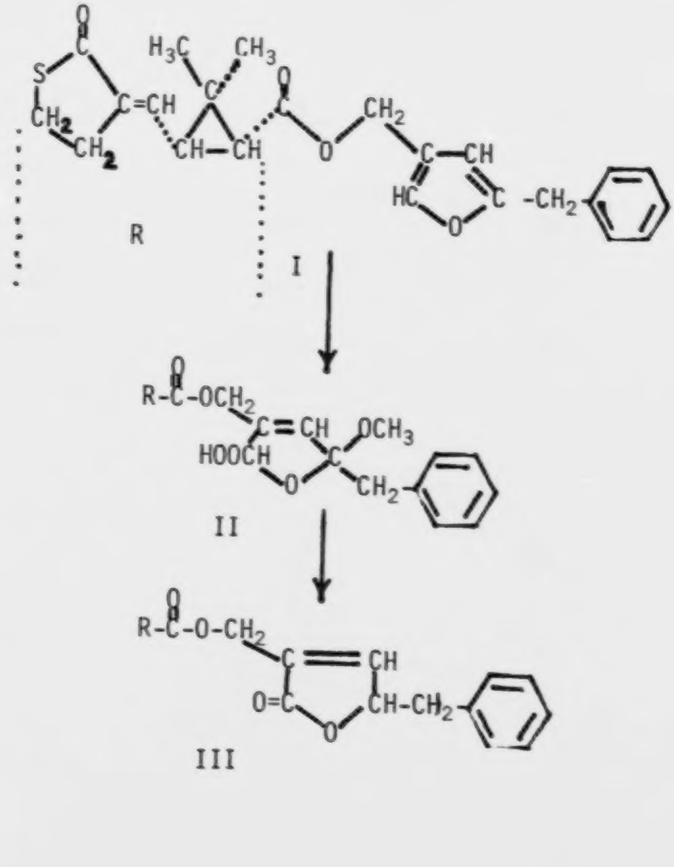
^{14}C-Benzyl-(+)-cis fenothrin (I) was administered to male Sprague-Dawley rats. About 65% was excreted via feces in 3 days. After chromatographic separation and cleanup, one metabolite was identified by NMR, IR and MS as 3-(4-hydroxyphenoxy)benzyl (±)-cis-chrysanthemate (II). Two other compounds were identified as 3-phenoxybenzyl (±)-cis-2,2-dimethyl-3-(3-(2-methylprop-2-enoic acid))cyclopropanecarboxylate (III) and 3-(4-hydroxyphenoxy)benzyl (±)-cis-2-hydroxymethyl-2-methyl-3-(3-(2-methylprop-2-enoic acid))cyclopropanecarboxylate (IV) (Suzuki et al., 1976).



	R_1	R_2	R_3
I.	H	CH_3	CH_3
II.	HO	CH_3	CH_3
III.	H	CH_3	COOH
IV.	HO	CH_2OH	COOH

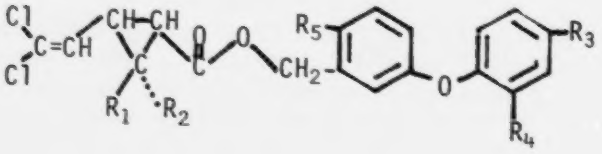
KADETHRIN [2-Benzyl-4-furylmethyl (±)-*cis*,*trans*-2,2-dimethyl-3-(2-oxo-tetrahydrothien-3-yl)methinyl cyclopropanecarboxylate]

When kadethrin (I) was exposed to sunlight, little of this compound degraded by epoxidation in the acid moiety, by thiolactone ring opening, or by ester hydrolysis. Isomerization in the acid moiety and oxidation of the furan ring initiated most of the photodegradation. Exposure of kadethrin films on glass to sunlight for 3 h or irradiation of kadethrin plus isobutyrophenone in benzene for 3 h at 350 nm produced a mixture of the four isomeric esters, *cis* and *trans* (Z) and *cis* and *trans* (E). When kadethrin was irradiated in oxygenated methanol with the sensitizer Rose Bengal, a methoxy derivative (II) formed which decomposed after 2 days to the ketone analog III (Ohsawa and Casida, 1978).



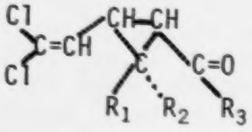
PYRETHRINS

PERMETHRIN [3-Phenoxybenzyl (±)-cis,trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate]



Cl
C=CH
Cl
CH—CH
C
R1
R2
O
C
O
CH2-
R5
O
R3
R4

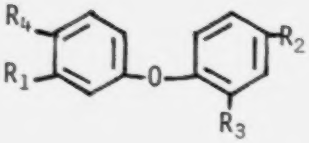
Compound	R_1	R_2	R_3	R_4	R_5
I	CH_3	CH_3	H	H	H
II	CH_2OH	CH_3	H	H	H
III	CH_2O-Gluc	CH_3	H	H	H
IV	CH_2OSO_3H	CH_3	H	H	H
V	CH_2OH	CH_3	OH	H	H
VI	CH_2OH	CH_3	Gluc	H	H
VII	CH_3	CH_2OH	H	H	H
VIII	CH_3	CH_2O-Gluc	H	H	H
IX	CH_3	CH_3	OH	H	H
X	CH_3	CH_3	Gluc	H	H
XI	CH_3	CH_3	H	OH	H
XII	CH_3	CH_3	H	H	OH
XIII	CH_3	CH_3	H	H	Gluc



Cl
C=CH
Cl
CH—CH
C
C=O
R1
R2
R3

Compound	R_1	R_2	R_3
XIV	CH_3	CH_3	OH
XV	CH_3	CH_3	Gluc
XVI	CH_3	CH_3	Glycine
XVII	CH_3	CH_3	Serine
XVIII	CH_3	CH_3	Glutamic Acid

Compound	R_1	R_2	R_3
XIX	CH_3	CH_3	Glutamine
XX	CH_2OH	CH_3	Taurine
XXI	CH_2OH	CH_3	OH
XXII	CH_2OH	CH_3	Gluc
XXIII	CH_3	CH_2OH	OH
XXIV	CH_3	CH_2OH	Gluc
XXV	CH_3	CH_2OSO_3H	OH
XXVI	CH_3	CH_2	O (lactone)



Compound	R_1	R_2	R_3	R_4
XXVII	CH_2OH	H	H	H
XXVIII	CH_2OGluc	H	H	H
XXIX	CH_2OH	OH	H	H
XXX	CH_2OH	Gluc	H	H
XXXI	CH_2OH	OSO_3H	H	H
XXXIa	CH_2OH	H	OH	H
XXXII	CH_2OH	H	H	OH
XXXIII	CH_2OH	H	H	Gluc
XXXIV	COOH	H	H	H
XXXV	$\overset{O}{\overset{\|}{C}}$-Gluc	H	H	H
XXXVI	$\overset{O}{\overset{\|}{C}}$-Glycine	H	H	H
XXXVII	$\overset{O}{\overset{\|}{C}}$-Glutamic	H	H	H
XXXVIII	$\overset{O}{\overset{\|}{C}}$-Glutamine	H	H	H
XXXIX	COOH	OH	H	H
XL	COOH	Gluc	H	H
XLI	COOH	OSO_3H	H	H
XLII	COOH	$NH-CH_2CH_2SO_3H$	H	H
XLIII	COOH	H	OH	H
XLIV	COOH	H	OSO_3H	H
XLV	COOH	H	H	OH
XLVI	COOH	H	H	Gluc

^{14}C-Labeled permethrin (I) was orally administered to lactating cows. Within 2-4 days after treatment ceased, ^{14}C dropped below 100 ppb. Excreta analyses showed the presence of the following metabolites: III, V, VII (2 isomers), VIII, IX, XIV, XV, XVIII, XXIII (2 isomers), XXVI, XXVII, XXVIII, XXXV, XXXVI, XXXVII, and XLIV. Liver contained unchanged permethrin, XIV, XXVII and unidentified compounds. The *cis*-isomer persisted longer than the *trans*-isomer and gave a larger proportion of ester metabolites (Gaughan et al., 1976 and 1978a).

When permethrin was administered orally to rats, the *cis*-isomer was more stable than the *trans*-isomer. Analyses of feces indicated that the *cis*-permethrin yielded the *cis*-isomers of compounds II, V, IX and XI while the *trans*-isomer yielded the *trans*-isomer of XI. Compound XLIV was obtained only with the *cis*-isomer. Other compounds excreted in feces and urine, isolated and identified, included both isomers of XIV, XV, XXI to XXIV, XXVI, XXVII, XXXIV to XXXVI and XLI. TLC cochromatography was used to identify the metabolites (Gaughan et al., 1976 and 1977). In other studies, [IR,*trans*]- and [IR,*cis*]-permethrin were synthesized and orally administered to rats. Compounds XIV and XXVII from the *trans*-isomer appeared mainly in urine whereas the metabolites from the *cis*-isomer appeared mainly in feces. The 3-phenoxybenzyl alcohol (XXVII) from *trans*-permethrin appeared in feces but not in urine and none of the urinary metabolites of either isomer retained the ester linkage. Most were conjugates found only in urine. Metabolites identified included: XIV, XV, XXI, XXIII, XXVII, XXXIV, XXXV, XXXVI, and XLI (Elliott et al., 1976).

Isotope studies with mouse liver MFO and esterase systems demonstrated that [IR,*trans*]-permethrin was preferentially oxidized at the 2-*cis*-methyl. Esterase specificity for *trans* esters of primary alcohols was confirmed and extended (Soderlund, 1977).

When ^{14}C-carbonyl and ^{14}C-methylene labeled [IRS]-*trans*- and [IRS]-*cis*-permethrin were administered orally to laying hens, the ^{14}C administered over a 3-day period was largely eliminated within one day afterwards. Residues of unchanged *cis*- and *trans*-permethrin were found in fat and eggs. Compounds were identified by TLC. Identified metabolites found in the excreta and eggs are summarized.

Compound	Excreta		Egg		Tissue
	*cis**	*trans**	*cis**	*trans**	
II	+		+		
IV	+		+		
V	+		+		
IX	+		+		
XIV	+	+	+	+	

Compound	Excreta		Egg		Tissue
	cis*	trans*	cis*	trans*	
XV	+	+	+	+	
XX	+	+			
XXI	+	+	+		+
XXIII	+	+		+	
XXV	+	+			
XXVI	+	+			
XXVII	+	+	+	+	
XXVIII	+	+			
XXIX	+	+	+	+	+
XXXI	+	+	+	+	
XXXIV	+	+			
XXXIX	+	+			+
XLI	+	+	+	+	

*Permethrin isomer used.

(Gaughan et al., 1978b)

^{14}C-Labeled [IRS,*trans*]- and [IRS,*cis*]-permethrin were administered to adult *Periplaneta americana*, adult *Musca domestica*, and larvae of *Trichoplusia ni* (cabbage looper). The *trans*-isomer was metabolized more rapidly than the *cis*-isomer. TLC and cochromatography were used to identify metabolites. Results of these studies are summarized.

Compound	Metabolites found					
	American cockroach		Housefly		Cabbage looper	
	cis*	trans*	cis*	trans*	cis*	trans*
II	+	+				
III			+	+		
V	+					
VI	+		+			
IX	+	+				
X	+		+	+	+	+
XII			+(1)	+(1)		
XIII			+	+		
XIV	+	+	+	+	+	+
XV	+	+	+	+	+	+
XVI	+	+	+	+	+	+
XVII					+	+
XVIII	+	+	+	+		
XIX	+	+				
XXI	+	+	+	+		+
XXIII	+	+				
XXIV			+			

Compound	Metabolites found (continued)					
	American cockroach		Housefly		Cabbage looper	
	*cis**	*trans**	*cis**	*trans**	*cis**	*trans**
XXVI	+		+			
XXVII	+	+	+	+	+	+
XXVIII			+	+	+	+
XXIX	+	+	+	+	+	+
XXX			+	+	+	+
XXXII			+(1)	+(1)		
XXXIII			+	+		
XXXIV	+	+	+	+	+	+
XXXVI			+	+	+	+
XXXVII	+	+	+	+		
XXXVIII	+	+				
XXXIX	+	+	+	+		
XL	+	+	+	+	+	+
XLV			+(1)	+(1)		
XLVI			+	+		

*Permethrin isomer used.
(1) From unpublished *in vitro* studies.

(Shono et al., 1978)

^{14}C-Acid- and alcohol-labeled *cis*- and *trans*-isomers of permethrin were applied topically to tobacco budworm [*Heliothis virescens* (F.)] and the bollworm [*Heliothis zea* (Boddie)]. Older larvae detoxified permethrin more rapidly than younger ones. Metabolism of *trans*-isomer was more rapid than *cis*-isomer and was more rapid in tobacco budworm than in bollworm. TLC and cochromatography were used to identify metabolites from internal and excreted material. Identified metabolites from bollworms and tobacco budworms from *cis*- and *trans*-permethrin included compounds IX, XII, XIV, XXVII, XXIX, XXXII, XXXIV, XXXIX and XLV. Compounds II and/or VII, XXI, XXIII and XXVI were tentatively identified. Authentic compounds were not available for comparison (Bigley and Plapp, 1978).

A comparative study of the hydroxylation of permethrin indicated species variation when microsomal-NADPH preparations of rat, mouse, trout and carp liver and housefly abdomens plus thoraces, and microsome plus soluble fractions of cabbage looper gut were incubated with *cis*- and *trans*-permethrin. Houseflies hydroxylated only the t-methyl of *trans*-permethrin; carp and looper preparations preferentially hydroxylated t-methyl of *cis*-permethrin. These studies are summarized:

Sites of Hydroxylation

Species	c-CH_3		t-CH_3		2'		4'		6	
	cis	*trans*	*cis*	*trans*	*cis*	*trans*	*cis*	*trans*	*cis*	*trans* (1)
Mouse	+	+	+	+	+(2)	-	+	+	+	+
Rat	+	+	+	+	-	-	+	+	-	-
Carp	+	+	+	+	-	-	+	+	-	-
Trout	-	+	+	+	-	-	+	+	-	-
Housefly	+	-	+	+	-	-	+	+	+	+
Looper	-	-	+	-	-	-	+	-	-	-

(1) Permethrin isomer used: *cis* = [IRS,*cis*]-permethrin
trans = [IRS,*trans*]-permethrin

(2) Only with tetraethyl pyrophosphate treated microsomes.

(Shono and Casida, 1978)

[IRS,*trans*]- and [IRS,*cis*]-Permethrin were applied topically to cotton or injected into bean plants. Degradation of the *trans*-isomer was more rapid than the *cis*-isomer and ester cleavage was the main reaction. Alcohol and acid fragments were conjugated. Minor pathways lead to hydroxylation of the esters at several sites. Photolytic effects caused some *trans/cis* isomerization. Metabolites isolated and identified by cochromatography were:

From cotton leaves (except as noted below, both permethrin isomers yielded their respective isomers of the following metabolites):

2'-hydroxypermethrin (XI)
4'-hydroxypermethrin (IX)
t-hydroxypermethrin (II)
t,4'-dihydroxypermethrin (V)
3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylic acid (XIV)
glycoside conjugate of XIV
t-hydroxyanalog of XIV (XXI)
c-hydroxy analog of XIV (XXIII)
3-phenoxybenzyl alcohol (XXVII)
3-phenoxybenzyl glycoside
c-lactone of XXIII (XXVI)

Metabolite XIV was not observed with *cis*-permethrin in field or greenhouse studies during the 6 weeks of the study. In the field studies, it was observed after 6 weeks. A number of unidentified conjugates were also present.

From bean plants:

two t- or c-hydroxypermethrin glycosides from trans-permethrin but only one glycoside from cis-permethrin

3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylic acid and c- and t-hydroxy analogs from both permethrin isomers; the glycoside of the acid from trans-permethrin only.

(Gaughan et al., 1976; Gaughan and Casida, 1978)

In other studies, the half-life of (+)-trans- and (+)-cis-permethrin applied to the leaf surface of bean plants was 7 and 9 days, respectively. Metabolites, identified by cochromatography, are summarized:

Metabolite	Isomer used (1)	
	cis	trans
2'-OH-4'-OH permethrin	+	+
Compound XIV	+	+
Compound XIV glucoside	+	+
Compound XXVII	+	+
Compound XXVII glucoside	+	+
Compound XXIX	+	+
Compound XXIX glucoside	+	+
Compound XXXIa	+	+
Compound XXXIa glucoside	+	+
Compound XXXIV	+	+

(1) Isomers used yielded their respective isomers.

(Ohkawa et al., 1977)

^{14}C-Permethrin was degraded rapidly in aerated nonsterile soil with evolution of $^{14}CO_2$ from carbonyl and methylene ^{14}C-labeled carbon. In flood or sodium azide treated soil, very little evolution of $^{14}CO_2$ was observed. The trans-isomer degraded more readily than the cis-isomers with ester hydrolysis yielding the cyclopropanecarboxylic acid and 3-phenoxybenzyl alcohol. The latter was oxidized to 3-phenoxybenzoic acid. About 30-60% of ^{14}C-labeled material (^{14}C-cyclopropyl-, ^{14}C-carbonyl-, and ^{14}C-methylene groups) applied was converted to $^{14}CO_2$. Ring hydroxylation yielded the 3-(4-hydroxyphenoxy)benzyl ester which was subsequently hydrolyzed (Kaufman and Jordan, 1976; Kaufman et al., 1978a, b and c). In other studies with soils under upland conditions, the respective isomers of the following metabolites were identified from trans- and cis-permethrin:

4'-hydroxy permethrin
3-phenoxybenzyl alcohol
3-phenoxybenzoic acid
3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylic acid (Cl_2CA),
  the *c*- and *t*-hydroxymethyl Cl_2CA analogs,
  the *c*-hydroxy-*t*-Cl_2CA lactone, and
  the *c*-hydroxy-*c*-Cl_2CA lactone

(Kaneko et al., 1978)

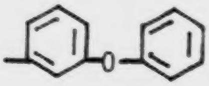
Trans- and *cis*-permethrin were irradiated in sunlight and at $\lambda > 290$ nm in hexane, methanol, water and water-acetone. Isomerization and ester cleavage occurred primarily. Observed products included monochloropermethrin and the monochlorovinyl acid from cleavage, 3-phenoxybenzyl 3,3-dimethylacrylate, 3-phenoxybenzaldehyde, 3-phenoxybenzoic acid, benzyl alcohol, benzaldehyde, 3-hydroxybenzyl alcohol, benzoic acid, 3-hydroxybenzoic acid, and 3-phenoxybenzyl alcohol (Holmstead et al., 1978a).

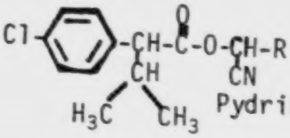
PHTHALTHRIN (Tetramethrin, Neo-Pynamin) [3,4,5,6-Tetrahydrophthalimidomethyl chrysanthemate]

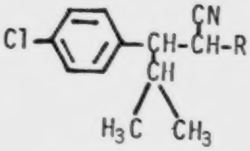
When phthalthrin was applied topically to houseflies, chromatography of extracts indicated the presence of chrysanthemic acid and N-hydroxymethyltetrahydrophthalimide. Three other compounds were not identified (Hayashi et al., 1968).

PYDRIN (SD-43775, S-5602, Fenvalerate, Sumicidin, α-Cyano-3-phenoxybenzyl α-(4-chlorophenyl)isovalerate) [α-Cyano-3-phenoxybenzyl α-isopropyl-4-chlorophenylacetate]

Pydrin photolysis in several solvents was examined at λ>290 nm. In methanol, hexane or 60:40 acetonitrile-water, the calculated half-lives were 18, 18 and 16 minutes, respectively. Chromatography and IR were used to identify the following products:

R =



Pydrin

I.


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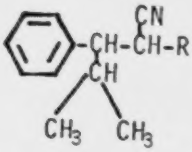

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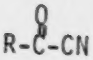
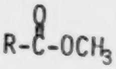
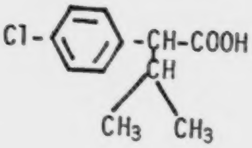

$R-\overset{O}{\overset{\|}{C}}-CN$

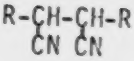
IV. R-COOH

V.

$R-\overset{O}{\overset{\|}{C}}-OCH_3$

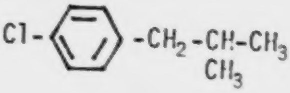
VI. RCHO

VII.


VIII. $R-CH_2-CN$

IX.

$R-\underset{CN}{CH}-\underset{CN}{CH}-R$

X. $R-CH_2-CH_2-R$

XI.


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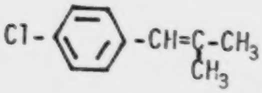

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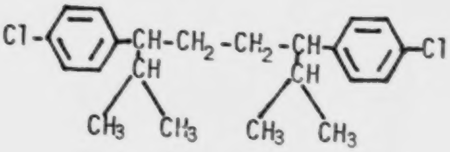
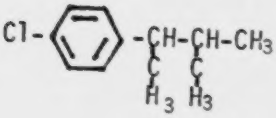
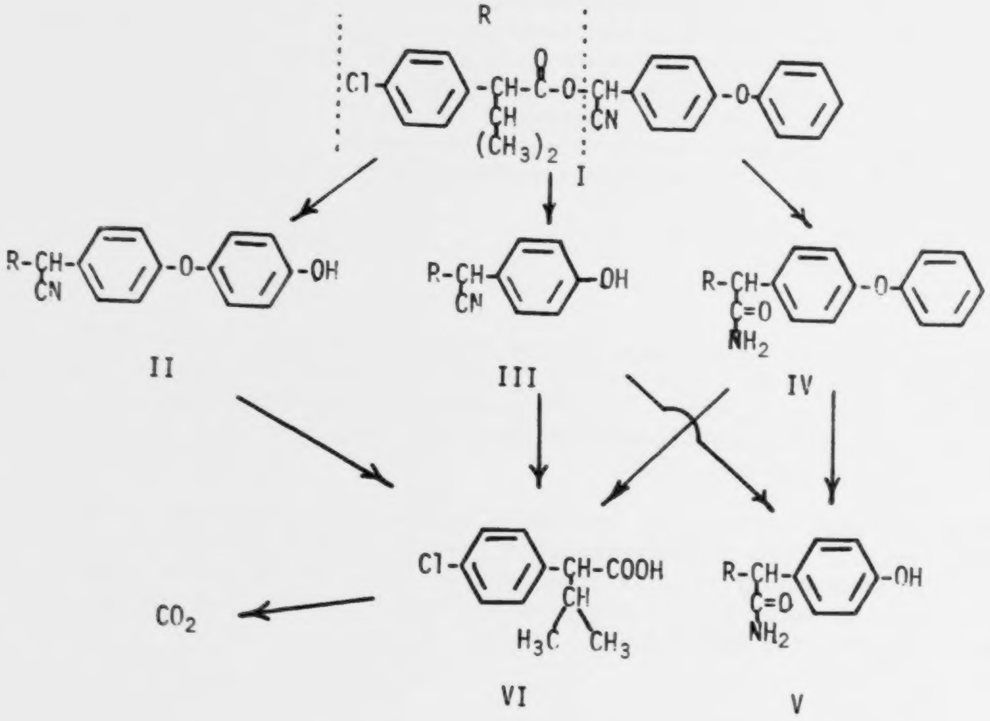


XIV.


Irradiation of pydrin thin films on glass in sunlight produced decarboxylated pydrin (I) in largest amount. Other products observed were I, II, IV, VI, VII, VIII, IX, XI, XII, XIII and XIV. Two other compounds were identified as R-CH_2OH (XV) and 1-chloro-4-(2-methylpropan-1-one)benzene (XVI). Pydrin half-life on glass was 4 days. On cotton pydrin half-life was about 8 days and the photoproducts identified were compounds I, IV, VI, VIII, XV and XVI (Holmstead et al., 1977 and 1978b).

^{14}C-CN- and ^{14}C-carbonyl-labeled fenvalerate was applied to soil at 25±2C and held under aerobic upland conditions. Using Kodaira and Azuchi soils, the half-life for this compound was 15 days and 3 months, respectively. Under anaerobic conditions, degradation was much slower. Metabolic products identified in soil included compounds II, III, IV, V, and VI. Other metabolites were present but not identified. CO_2 was also obtained from fenvalerate labeled in CN as well as the carbonyl. Culture solutions of bacteria and fungi actively degraded fenvalerate. Hydrolysis of the CN group also occurred in sterilized soils. The $CONH_2$-fenvalerate was the main product in clay minerals such as kaolinite and montmorillonite. Although not found in soils, COOH-fenvalerate was produced in culture solutions of soil microorganisms (Ohkawa et al., 1978).



WL 41706 (Sumitomo S3206) [(±)-α-Cyano-3-phenoxybenzyl 2,2,3,3-tetramethylcyclopropanecarboxylate]

WL 41706, labeled in the benzyl or in the cyclopropyl group, was administered to rats. In 48 h, about 57% of the benzyl-^{14}C was excreted via urine and 40% in feces. Some (0.005% of the dose) radioactivity appeared as $^{14}CO_2$. No sex difference was observed. Chromatographic and/or MS analyses identified the following metabolites:

(U,F)*	I.	3-phenoxybenzoic acid
(U)	II.	N-(3-phenoxybenzoyl)glycine
(U,F)	III.	3-(4-hydroxyphenoxy)benzoic acid
(U,B)	IV.	sulfate of 3-(4-hydroxyphenoxy)benzoic acid
(F)	V.	2,2,3,3-tetramethylcyclopropanecarboxylic acid glucuronide
(F)	VI.	3-phenoxybenzaldehyde
(F)	VII.	3-(4-hydroxyphenoxy)benzyl alcohol
(F)	VIII.	3-phenoxybenzyl alcohol
(F)	IX.	α-cyano-3-phenoxybenzyl trans-2-hydroxy-2,3,3-trimethylcyclopropanecarboxylate
(B)	X.	α-cyano-3-(4-hydroxyphenoxy)benzyl 2,2,3,3-tetramethylcyclopropanecarboxylate glucuronide
(B)	XI.	3-phenoxybenzyl glucuronide
(B)	XII.	glucuronide of compound IX
(B)	XIII.	3-phenoxybenzoic acid glucuronide
(B)	XIV.	3-(4-hydroxyphenoxy)benzoic acid glucuronide

* U = urinary metabolite
F = fecal metabolite
B = biliary metabolite

Incubation of rat microsomes in the presence of NADPH and WL 41706 produced metabolite IX primarily (>70%) plus small amounts of I and VIII. Traces of compound III and α-cyano-3-(4-hydroxyphenoxy)benzyl 2,2,3,3-tetramethylcyclopropanecarboxylate (XV) were also present (Crawford and Hutson, 1977).

When incubated with soils, the main degradation pathway was ester hydrolysis to form 3-phenoxybenzoic acid (I) and 2,2,3,3-tetramethylcyclopropanecarboxylic acid (XVI). Hydrolysis of the cyano group produced the amide (XVII) and carboxylic acid (XVIII) derivatives of WL 41706 (Roberts and Standen, 1977b).

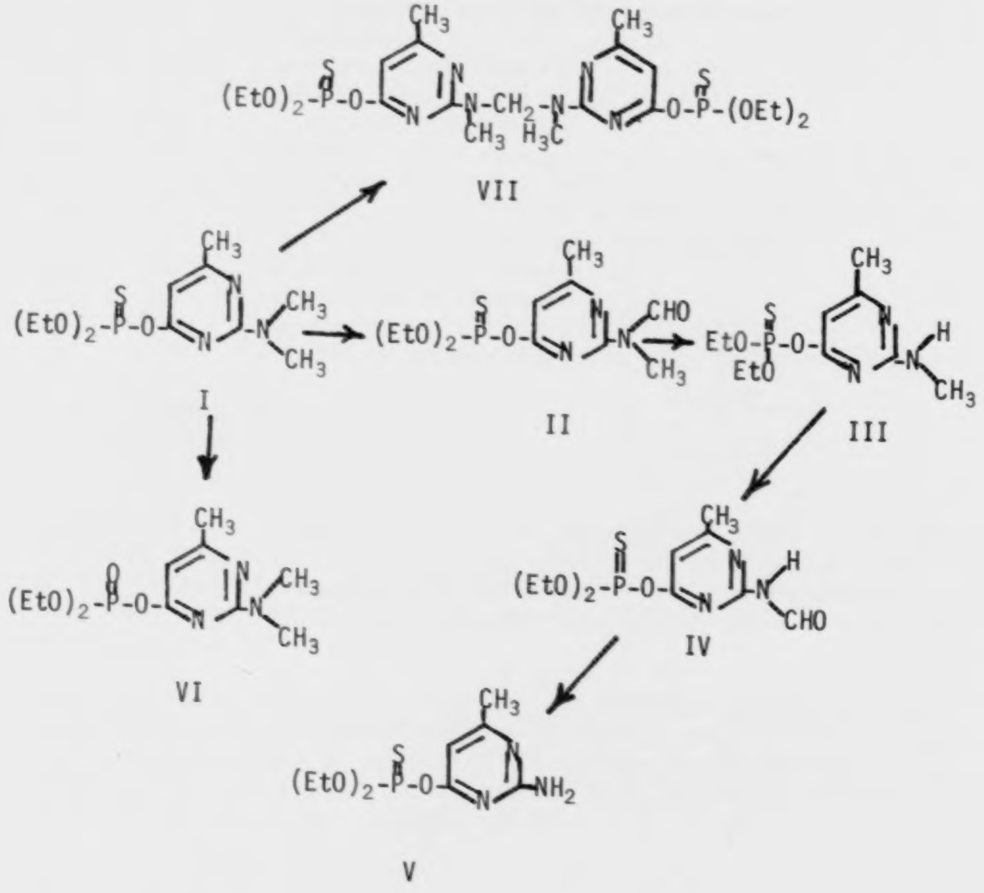
PYRIDAFENTHION [O,O-Diethyl O-(3-oxo-2-phenyl-2H-pyridazin-6-yl) phosphorothioate]

For 3 weeks, a mouse was orally administered pyridafenthion 20 mg/kg. The rate of excretion was the same as when a single dose (20 mg/kg) was given. Analysis of urine showed the presence of desethyl pyridafenthion, desethyl pyridafenthion oxon, phenyl maleic hydrazide and its glucuronide (Udagawa et al., 1974).

PYRIMITHATE [*O*,*O*-Diethyl *O*-2-dimethylamino-6-methylpyrimidin-4-yl phosphorothionate]

On Na-kaolinite, pirimphos ethyl was lost by hydrolysis of the phosphate ester. In addition to diethyl thiophosphate, three other metabolites were observed. One was thought to be the pyrimidine product of the phosphate ester bond hydrolysis. The other two were not identified. There was significant rate of hydrolysis on air-dried Na-kaolinite at 23C and 47C and on oven-dried and air-dried Na-bentonite at 47C (Mingelgrin et al., 1975).

When pyrimithate (I) was exposed to UV in air, a mixture of products was formed. Five of these products were isolated and identified by NMR, electron impact MS, and IR as compounds II, III, IV, VI and VII. A sixth compound was tentatively identified as compound V (Machin et al., 1974).



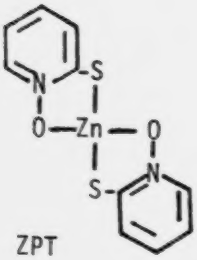
PYRITHIONE [Pyridine-2-thiol-1-oxide]

Zinc pyrithione = ZPT
Sodium pyrithione = NPT
Magnesium sulfate adduct of 2,2'-dithio-bis(pyridine-1-oxide) = MDS

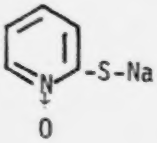
ZPT, NPT and MDS were given i.v. to mature female Yorkshire swine. Urine was collected and analyzed. The major metabolite present was identified as the *S*-glucuronide of 2-mercaptopyridine-*N*-oxide (II) and the minor one as *S*-glucuronide of 2-mercaptopyridine (III). After dermal application to swine, the following metabolites were observed:

IV. 2,2'-pyridyldisulfide
V. 2-(pyridyl-*N*-oxide)sulfonic acid

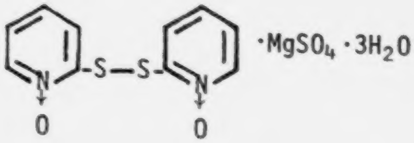
Other compounds were observed but not identified (Wedig et al., 1978).



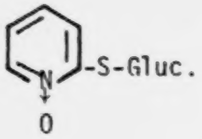
ZPT



NPT



MDS



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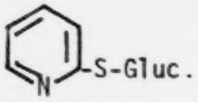

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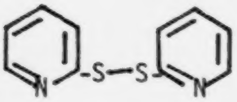

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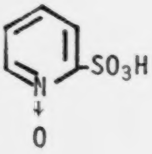


V

Quaternary Ammonium Compounds

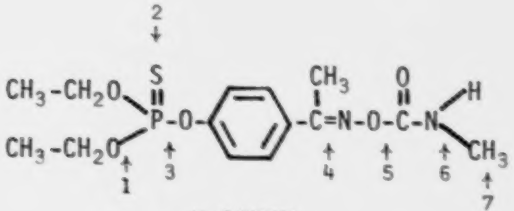
The metabolism of quaternary ammonium compounds was investigated. Cultures of microorganisms were obtained, by enrichment culture, that were able to grow on 10mM tetramethylammonium chloride (TMA) and ethyl trimethylammonium chloride (ETMA); but these organisms would not grow on higher homologues (Mackrell and Walker, 1978).

In other studies, the decyl- (DTMA) and hexadecyl- (HTMA) trimethylammonium bromides were decomposed by a mixed culture of *Pseudomonas* sp. and *Xanthomonas* sp. from sewage and soil. In a solution of DTMA and other organic molecules, the xanthomonad decomposed DTMA with formation of 9-carboxynonyl- and 7-carboxyheptyl-trimethylammonium compounds. Other compounds corresponding to 174, 146, and 118 mass units indicated β-oxidation and loss of 28 mass units which is equivalent to CH_2-CH_2 (Dean-Raymond and Alexander, 1977).

R-14805 [4-*O*-(*O*,*O*-Diethyl phosphorothioyl)acetophenoneoxime-*N*'-methylcarbamate]

[Phenyl-^{14}C]-R-14805 was administered orally to rats. About 96% of the dose was excreted within 72 h, 91% in the urine. Metabolism of R-14805 involved oxon formation, desethylation, and desarylation. In addition to these transformations, hydrolysis of the oxime C=N and O-C-, and *N*-demethylation or hydroxylation occurred. Five oxons, three desethylated oxons, and four desarylation products were observed. The aryl products were excreted as sulfate and glucuronide conjugates (McBain et al., 1978).

In water, hydrolysis of R-14805 was slow at pH 5-9 but more rapid in 0.02 N HCl or NaOH ($T_{1/2}$ = 48 and 2 h, respectively). Photolysis in sunlight caused cleavage of the C=N and P-O bonds and attack on the sulfur (McBain et al., 1978).



R-14805

RAFOXANID [3'-Chloro-4'-(4-chlorophenoxy)-3,5-diiodosalicylanilide]

When rafoxanide was administered in oil orally to cattle, the half-life was found to be related to dosage. At 5 mg/kg, the $t_{1/2}$ = 7 days in blood (Dedek et al., 1977). At a level of 12 mg/kg, in the blood the $t_{1/2}$ = 12 days in cattle and at 17 mg/kg in sheep the $t_{1/2}$ = 10.5 days. This compound was also found to be adsorbed to proteins in blood (Dedek et al., 1976b). Analysis of urine of lactating cows showed the presence of 3,5-diiodosalicylic acid and 3-chloro-4-(4'-chlorophenoxy)aniline (Dedek et al., 1978b).

RONNEL (Trolene) [O,O-Dimethyl O-(2,4,5-trichlorophenyl)phosphorothioate]

When rats were exposed to ronnel, urine contained dimethyl phosphate and O,O-dimethyl phosphorothioic acid (Bradway et al., 1977).

In vitro studies with preparations from rat brain and liver, indicated the formation of the oxygen analog of ronnel and that this was the source of ronnel toxicity (Sitkiewicz et al., 1977).

S-2571 [O-Ethyl O-(2-nitro-5-methylphenyl) N-isopropyl phosphoramidothioate]

S-2571 exists in the form of several enantiomers. Each was stereoselectively metabolized, when incubated with rabbit liver MFO, to the oxon analog and 5-hydroxymethyl derivatives of S-2571 and the oxon. Other compounds observed were the 2-nitro-5-methylphenol, 2-nitro-5-hydroxymethylphenol, and the 5-formyl analog of S-2571 (Mikami et al., 1977a; Ohkawa et al., 1976a). Oxidation of S-2571 with m-chloroperoxybenzoic acid also gave stereoselective oxidation of the enantiomers (Mikami et al., 1977a).

Photooxidation of racemic S-2571 with UV light produced the oxon and 2-nitro-5-methylphenol (Mikami et al., 1977a).

SALITHION [2-Methoxy-4H-1,3,2-benzodioxaphosphorin-2-sulfide]

After oral administration of benzyl-^{14}C-salithion to male rats, most of the label was recovered in urine within 24 h. At least 15 metabolites were observed. Six were identified by cochromatography, IR and NMR as salioxon, saligenin, desmethyl salithion, desmethyl salioxon, O-(2-hydroxybenzyl)dihydrogen phosphate, and O-(2-hydroxybenzyl)dihydrogen phosphorothioate (Mihara and Miyamoto, 1974).

Most of the ^{14}C-salithion applied to bean and rice plants was vaporized. Salithion taken up by plants was degraded by cleavage of the cyclic phosphorus ester group. Saligenin which formed was conjugated with glucose at the benzyl hydroxy group. Salicin (2-hydroxybenzyl alcohol) was conjugated similarly at the 2-hydroxy group. In addition to these conjugates, salioxon, saligenin, desmethyl salithion, and O-(2-hydroxybenzyl)dihydrogen phosphorothioate were observed (Mihara and Miyamoto, 1974).

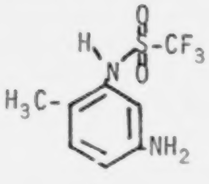
In acetone and air, photodecomposition in sunlight proceeded rapidly. The $t_{1/2}$ was 60 minutes and the main decomposition product was identified as O-methyl O-(2-carboxyphenyl)phosphate (IX). Other compounds observed were S-benzyl salithion (II), salicylic acid (IV), salioxon (V), O-methyl O-(2-carboxyphenyl)phosphorothioate (VIII), O-methyl O-(2-formylphenyl)phosphate (VII), and the phosphorothioate (VI). $^{14}CO_2$ was also produced from ^{14}C-salithion. In water solution, photodecomposition was slow. Compounds observed included II, V, VII and IX plus saligenine (III), O-methyl O-(2-hydroxybenzyl)phosphorothioate (X) and the phosphate (XI). On silica gel plates exposed to sunlight, salithion yielded compounds II, V, VII, IX, X, and XI. On soil surface exposed to sunlight, salithion yielded III, V, VI, VII, X and XI (Mikami et al., 1977b).

SRA 12869 [1-Methylethyl-2-[[ethoxy[(1-methylethyl)amino]phosphino-
thioyl]oxy]benzoate]

^{14}C-SRA 12869 was applied to soil in which corn was grown. Analysis indicated the uptake of radioactivity and the presence in corn of SRA 12869 and its oxygen analog (Stanley and Murphy, 1975).

SUSTAR [N-(3-(1,1,1-Trifluoromethylsulfonylamino)-4-methylphenyl) acetamide]

Sustar was dissolved in phosphate buffer and exposed to sunlight or UV light. At pH 3.4, degradation was about 3 times as rapid as at pH 7.2. Extensive ring oxidation occurred with formation of CO_2. When sustar in phosphate buffer (pH 7.5) was exposed to mercury arc irradiation, compounds X, XIII and XIV were found. At pH 3.6, the irradiation produced compound X primarily. Compounds IV, VI and XI were present in significant amounts and compounds II, VII, VIII and IX were present in small amounts. At pH 7.2, photochemical reactivity of sustar was low but the products were the same as in acidic solution except for one additional compound not identified. Exposure of sustar in natural water produced no detectable photoproducts within 17 days (Miller and Crosby, 1978).



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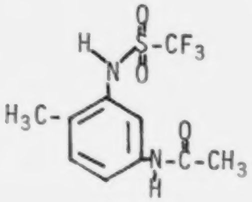

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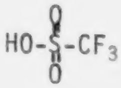
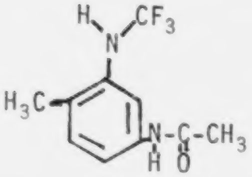


$$HO-\overset{O}{\underset{O}{S}}-CF_3$$

III



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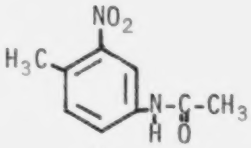

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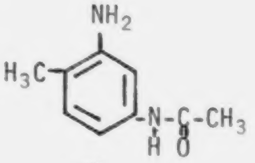

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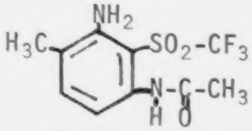

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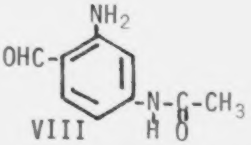

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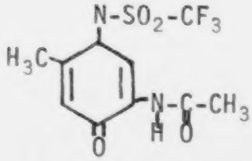

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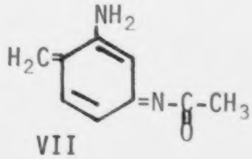

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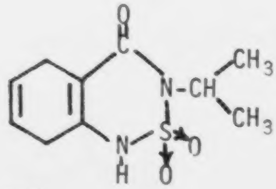

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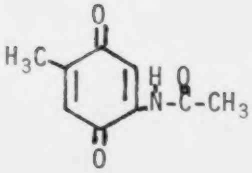
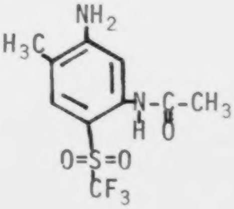


X

$H_2N-SO_2-CF_3$

XI



XIV

TCPH [*p*-Toluoyl chloride phenylhydrazone]

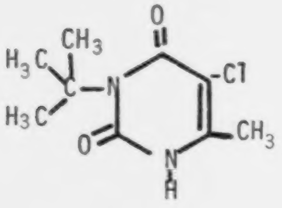
Within 10 days after a single oral therapeutic dose to sheep, ^{14}C-TCPH labeling was excreted primarily (74%) in feces. In plasma, the phenylhydrazine portion was bound to heme of erythrocytes (Jaglan et al., 1976).

TERBACIL [3-*tert*-Butyl-5-chloro-6-methyluracil]

Orange seedlings were grown in solutions containing ^{14}C-terbacil. Analysis of plant tissues showed the presence of the 6-hydroxymethyl analog and a conjugate believed to be the β-glucoside (Jordan et al., 1975).

Alfalfa was treated with 1 lb a.i. terbacil/acre. Two metabolites were identified by TLC and MS as 3-*t*-butyl-5-chloro-6-hydroxymethyluracil (II), and 6-chloro-2,3-dihydro-7-hydroxymethyl-3,3-dimethyl-5H-oxazolo[3,2-a]pyrimidin-5-one (V). Two other compounds observed were believed to be 3-*t*-butyl-6-hydroxymethyluracil (III) and 6-chloro-2,3-dihydro-7-methyl-3,3-dimethyl-5H-oxazolo[3,2-a]pyrimidin-5-one (IV) (Rhodes, 1977b).

Terbacil was lost from orchard soil by degradation and leaching. The time required for loss of 50% in soil concentration was 5-7 months. Terbacil residues were phytotoxic to oats planted 3 years after the last application (Marriage et al., 1977).



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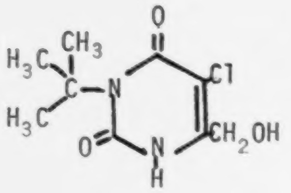
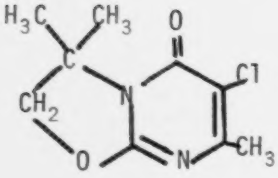
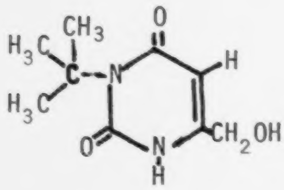


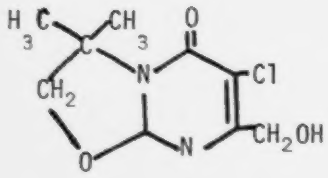
II



IV



III



V

TERBAM [3-*tert*-Butylphenyl *N*-methylcarbamate]

Terbam was applied to the green rice leafhopper (*Nephotettix cincticeps* Uhler) and the smaller brown planthopper (*Laodelphax straitellus* Fallen). Penetration into the insect was rapid and about 10-12 metabolites were formed. Only the *N*-hydroxymethyl metabolite was identified (Kazano et al., 1978).

TERBUFOS (Counter) [O,O-Diethyl S-(1,1-dimethylethylthiomethyl) phosphorodithioate]

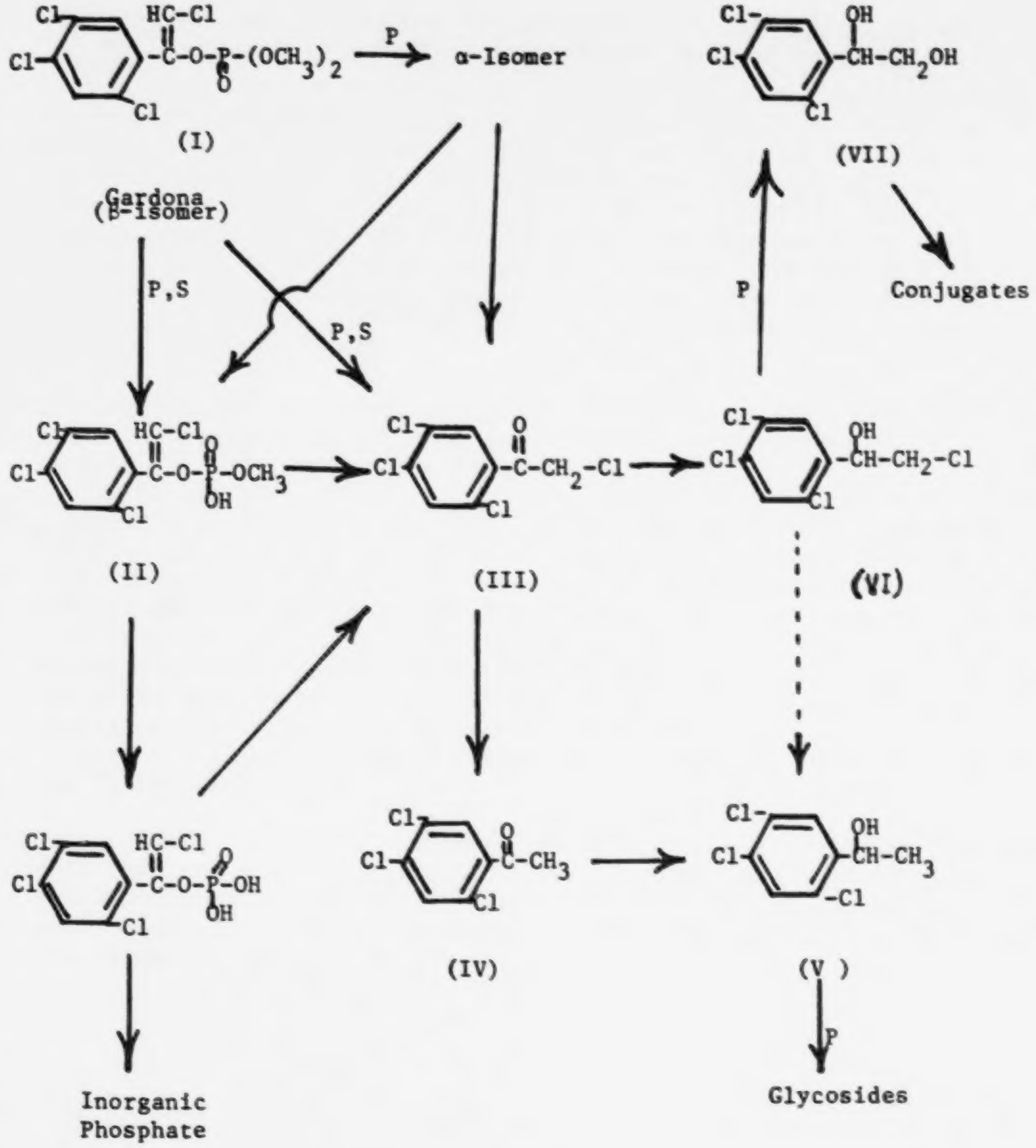
In a silt loam soil, the $t_{1/2}$ for terbufos was about 10 days. In addition to formation of CO_2, terbufos sulfoxide and sulfone were formed as the major metabolites. Further degradation produced t-butylthiomethanethiol. This was methylated and in turn converted to a disulfoxide, two isomeric sulfoxide-sulfones, and a disulfone. Terbufos oxon and its sulfoxide and sulfone were also present in small amounts (Barringer et al., 1978).

TETRACHLORVINPHOS (Gardona, Rabon) [2-Chloro-1-(2,4,5-trichlorophenyl) vinyl O,O-dimethyl phosphate]

The 105000g soluble fraction from chicken liver homogenates was prepared. Enzymes present metabolized tetrachlorvinphos. The reaction was glutathione dependent with desmethylation occurring and producing S-methylglutathione and desmethyl tetrachlorvinphos. Further metabolism produced 2,4,5-trichloroacetophenone, 1-(2,4,5-trichlorophenyl) ethanol, and 2-chloro-1-(2,4,5-trichlorophenyl)ethanol. Co-chromatography and GC-MS were used to confirm identity of the metabolites (Akhtar and Foster, 1977). In other studies, when this was incubated with II, compounds III, IV, V and VI were produced. Compounds V and VI were present in the benzene extracts of all incubation mixtures. Compounds III and IV were present up to about 75 minutes but could not be detected at 180 minutes. Co-chromatography and GC-MS were used to identify the metabolites. The presence or absence of GSH did not affect the rate of metabolism of compound II. The enzyme probably catalyzed hydrolysis of II. Increased GSH concentrations increased the rate of formation of V. Conversion of compound VI to compound V did not occur even in the presence of GSH. A chlorinated amino acid was detected but not identified. It was believed to be S-(2,4,5-trichlorophenacyl)glutathione which would yield S-(2,4,5-trichlorophenacyl) cysteine, glutamic acid and glycine upon acid hydrolysis (Akhtar, 1978).

In acidic and basic media, tetracahlorvinphos decomposition was mainly via dephosphorylation to form 2,4,5-trichlorophenacyl chloride. In alkaline media this compound then underwent an aldol condensation to form 1-(2,4,5-trichlorobenzoyl)-2-(2,4,5-trichlorophenyl)glycerol. Identification of the latter was made by MS and IR (Akhtar, 1977).

In a study of the metabolism of phosphate esters, an enzyme was obtained from the soluble fraction of rat and pig liver homogenates that was capable of hydrolyzing gardona. The enzyme was inhibited by phosphoric acid monoesters, inorganic phosphate, and high (1 mM) concentrations of CU^{++}, Zn^{++} and Fe^{+++}. EDTA (10 mM) activated the enzyme (Donninger et al., 1971).


(I)
Gardona
(β-Isomer)
P
α-Isomer
P,S
P,S
(II)
(III)
(IV)
(V)
(VI)
(VII)
P
Conjugates
P
Inorganic
Phosphate
Glycosides

P=Plants

S=Soil

THANITE [Isobornyl thiocyanoacetate]

When exposed to thanite, fish released -CN and substituted the residue with a methyl group to form isorbornyl α-(methylthio)acetate (Allen et al., 1978).

THIABENDAZOLE (TBZ) [2-Thiazol-4'-ylbenzimidazole]

A single oral dose of TBZ was administered to four male human subjects. Feces and urine were collected. After an oral dose of 1.0 g TBZ-^{14}C, plasma levels peaked at 1 to 2 h and large amounts of radioactivity appeared rapidly in the urine. More than 40% of the label was excreted within 4 h and 80% in 24 h. Most of the dose appeared in urine as the glucuronide (25%) and sulfate (13%) of 5-hydroxy-TBZ. A small amount of unchanged TBZ and unconjugated 5-HO-TBZ were also present. The same compounds were observed with rats and dogs (Tocco et al., 1966). It has also been reported that ^{14}C-labeling of the benzene ring in thiabendazole gave rise to some $^{14}CO_2$ by rats, indicating ring cleavage (Rosenblum et al., 1964).

Rat hepatic MFO preparations hydroxylated thiabendazole. This activity seemed to be greatest in microsomal preparations > hepatocytes > slices (Gerayesh-Nejad et al., 1975).

Photolysis of thiabendazole (TBZ) in methanol for 9 days produced a pale yellow solution. The methanol distillate contained dimethyl oxalate and other materials. Treatment of the residual oil with ammonia and then vacuum evaporation produced ammonium formate. The remaining oil was added to an alumina column and elution with ether-methanol mixtures yielded thiazole-4-carboxamide, identified by IR, MS, and mixed melting point; benzimidazol-2-carboxamide, identified by MS; benzimidazole, identified by comparison of physical characteristics; thiazol-4-ylamide and methyl thiazole-4-carboxylate, identified by IR and MS (Watkins, 1976).

Increasing soil acidity increased adsorption of TBZ. Studies indicated this resulted from ionization at lower pH values and adsorption of ionized molecules. After 9 months, 85-95% of the TBZ applied to soil was recovered from air dried soils; 75-90% from moist soils (Aharonson and Kafkafi, 1975a and b).

THIOFANOX (Dacamox) [3,3-Dimethyl-1-methylthio-O-(methylaminocarbonyl)-2-butanone oxime]

In potato tubers, ^{14}C-thiofanox appeared as bound residues. The action of α-amylase and β-glucosidase released the sulfone (II), the sulfoxide (III), and the N-methyl hydroxylated analog (IV). The oximes of II, III, IV and the ketone 3,3-dimethyl-1-methylsulfonyl-2-butanone were also observed. Methionine was labeled by S-methyl transfer (Meeks and Stallard, 1978b).

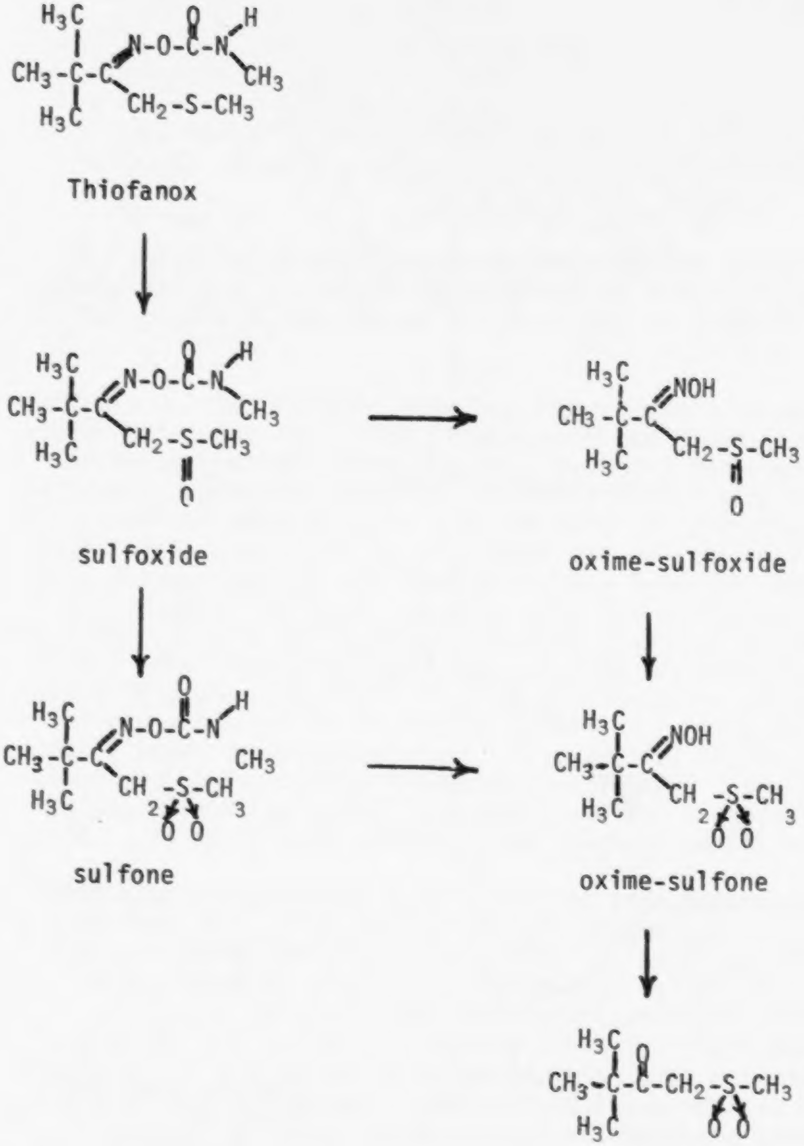
Potato plants were treated at planting with thiofanox. Residue analyses indicated the presence of thiofanox sulfoxide, thiofanox sulfone and small amounts of 3,3-dimethyl-1-(methylsulfonyl)-2-butanone oxime (Chin et al., 1976a).

Thiofanox was applied to cottonseeds prior to planting. This was taken up by young seedlings and translocated to cotyledons and leaves. Metabolism of the thiofanox was rapid. Products identified in the leaves included thiofanox sulfoxide and sulfone and unidentified water-soluble materials (Holm et al., 1975).

In an aquatic environment, thiofanox was rapidly oxidized to the sulfoxide, then to the sulfone, and hydrolysis to the oxime. In plants, the sulfoxide was absorbed and converted to the sulfone, which was cleaved to the oxime and conjugated. Some methane was also formed (Meeks and Stallard, 1978a).

Thermal decomposition of thiofanox gave rise to the following compounds: 3,3-dimethyl-1-methylthio-2-butanone oxime; methyl isocyanate; 3,3-dimethyl-1-methylthio-O-(N,N'-dimethylallophanoyl)-2-butanone oxime. The latter decomposed primarily to 3,3-dimethyl-1-methylthio-2-butanone oxime, N,N'-dimethylurea, CO_2, pivalonitrile, methylthioacetonitrile, dimethyl sulfide, dimethyl disulfide and isobutane (Corkins et al., 1978).

In acidic and neutral solutions, thiofanox was stable. At pH 10, oxidation to the sulfoxide occurred. Hydrolysis of thiofanox to the corresponding oxime (3,3-dimethyl-1-methylthio-2-butanone oxime) was insignificant. Partial hydrolysis of thiofanox sulfoxide to the corresponding oxime occurred. Hydrolysis of the thiofanox sulfone apparently occurred to a greater extent and was the principal source of the oxime-sulfone (3,3-dimethyl-1-methylsulfonyl-2-butanone oxime). Loss of oxime was detected after 5 days with formation of a keto-sulfone (Chin et al., 1976b).


Thiofanox
sulfoxide
oxime-sulfoxide
sulfone
oxime-sulfone

THIOLCARBAMATE

BENTHIOCARB

BUTYLATE

CYCLOATE

DIALLATE

EPTC

PEBULATE

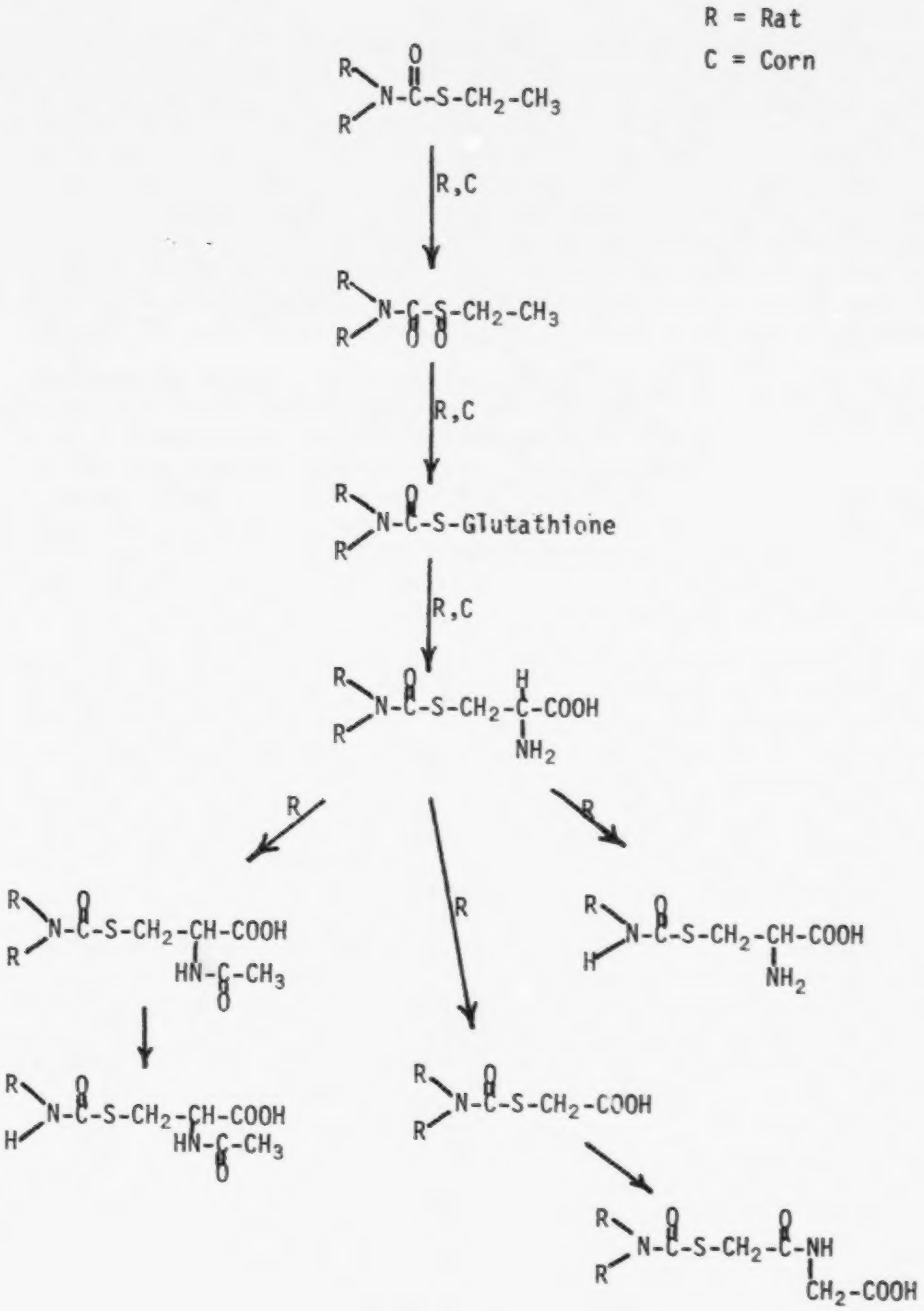
TRIALLATE

VERNOLATE

Thiolcarbamates can be converted to the respective sulfoxide and sulfone by reaction with appropriate equivalents of *m*-chloroperoxybenzoic acid in $CHCl_3$ or CH_2Cl_2 at -15 to 25C and 15 minutes to 2 h (Casida et al., 1974).

Thiolcarbamates were not metabolized when incubated with mouse liver microsomes until NADPH had been added. Sulfoxides were then formed. The sulfones were not detected. Incubation of the sulfoxides with mouse liver soluble fraction and GSH produced a cleavage, probably at the carbonyl group, to give products not individually identified. One minor EPTC metabolite was identified as the *N*-despropyl analog. *In vivo* studies indicated that in mammals the thiolcarbamates were converted to sulfoxides and then cleaved. When *S*-[^{14}C]methylene-EPTC and pebulate and their sulfoxides were given to mice, about 40% of the dose appeared as $^{14}CO_2$ and the remainder almost entirely in the urine. Seven organosoluble metabolites of EPTC and EPTC sulfoxide appeared in the urine. The major metabolite in each case was identified as ethyl methyl sulfone by TLC cochromatography. When injected with ^{14}C-EPTC and ^{14}C-pebulate, corn seedlings contained the corresponding sulfoxides 8 h after treatment. These did not accumulate to high levels and no sulfones were detected (Casida et al., 1974).

[^{14}CO]Thiolcarbamates were administered to rats. Relatively large amounts of $^{14}CO_2$, as compared to ^{14}C in the urine, were expired. Analyses of urine, feces and liver indicated that these compounds were metabolized via two pathways. One pathway produced larger amounts of $^{14}CO_2$ from thiolcarbamates than from the sulfoxide derivatives and their GSH and cysteine conjugates. In the other pathway, metabolism of a thiolcarbamate proceeded via the sulfoxide and *S*-(*N*,*N*-dialkylcarbamoyl)glutathione. Degradation of the glutathione conjugate produced the corresponding cysteine conjugate, mercapturic acid and mercaptoacetic acid. The appropriate mercapturic acids were seen in urine when benthiocarb, cycloate, molinate and pebulate were administered to rats (Hubbell and Casida, 1977).



R = Rat
C = Corn

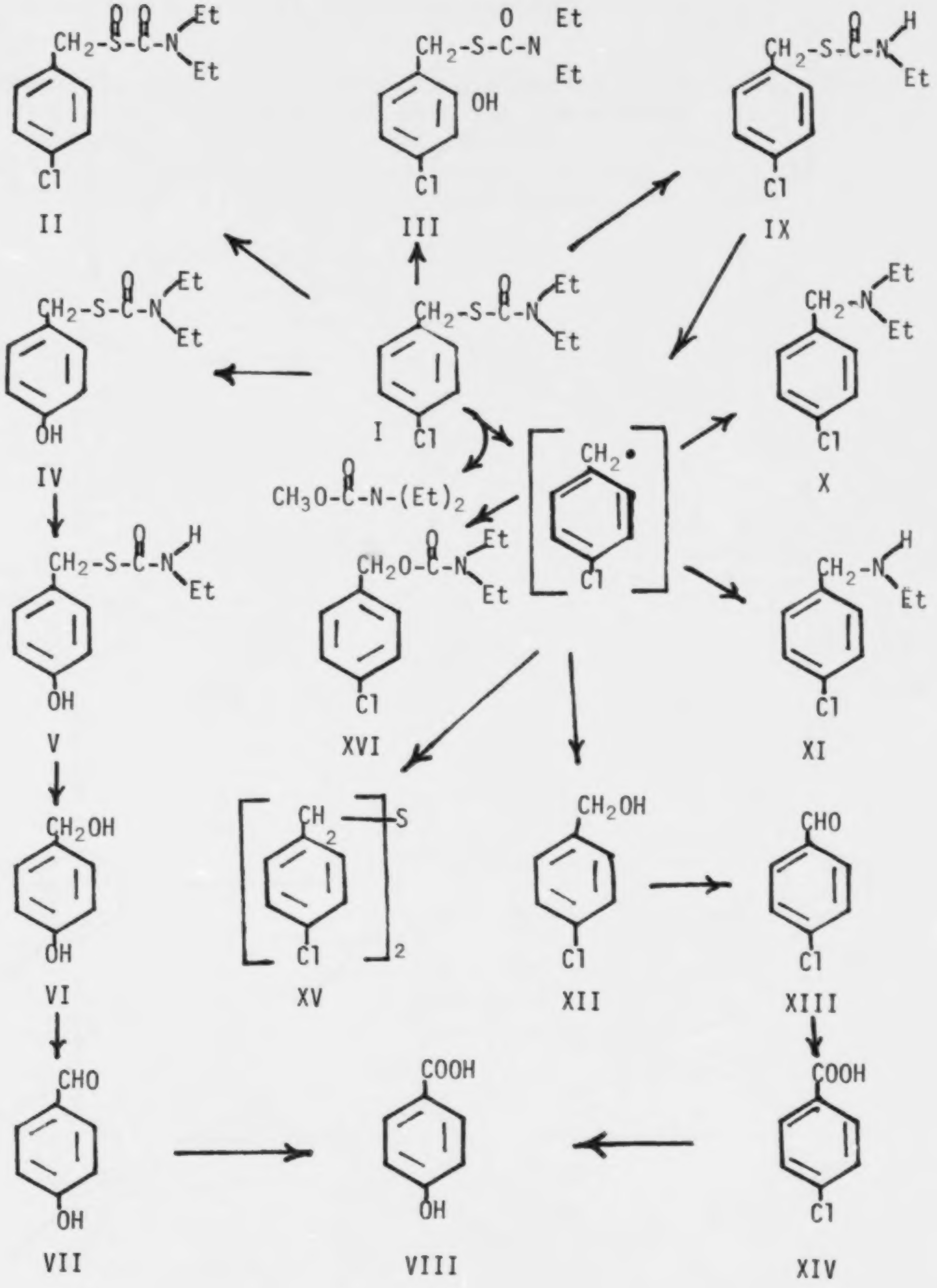
BENTHIOCARB (Saturn) [*S*-4-Chlorobenzyl *N*,*N*-diethylthiolcarbamate]

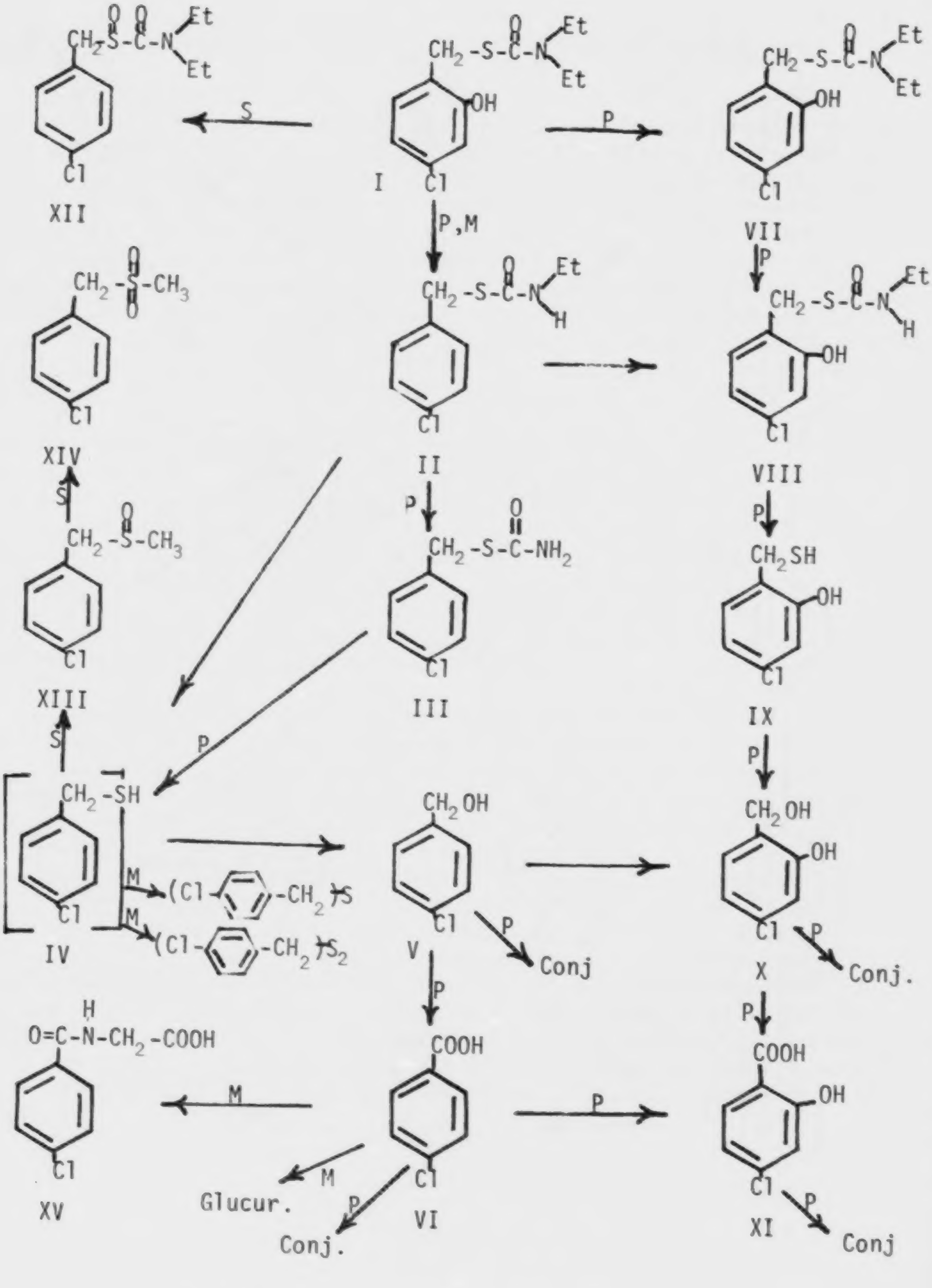
Roots of rice and barnyard millet were soaked in ^{14}C-benthiocarb solution for 48 h. Degradation was rapid and most of the radioactivity in the plants was extractable with aqueous acetone. The same metabolites were observed in root and foliage of both plants and little difference in the metabolic pattern of both plants was observed. The metabolites were identified as desethyl benthiocarb (II), *S*-4-chlorobenzyl thiocarbamate (III), 4-chlorobenzoic acid (VI), 2-hydroxybenthiocarb (VII), desethyl 2-hydroxybenthiocarb (VIII), 4-chloro-2-hydroxybenzyl alcohol (X), and 4-chlorosalicylic acid (XI). Hydrolysis of unextractable radioactivity with β-glucosidase and HCl yielded the aglycons identified as compounds V, VI, VII, VIII, X, and XI (Nakamura et al., 1977a).

In soil studies, ^{14}C-benthiocarb was degraded to about 20 compounds detectable by TLC. In addition to unchanged benthiocarb (I), desethyl benthiocarb (II), benthiocarb sulfoxide (XII), 4-chlorobenzoic acid (VI), 2-hydroxybenthiocarb (VII), 4-chlorobenzyl methyl sulfone (XIV), 4-chlorobenzyl methyl sulfoxide (XIII), and 4-chlorobenzyl alcohol (V) were observed (Ishikawa et al., 1976). Under oxidative conditions, benthiocarb was rapidly degraded and $^{14}CO_2$ was released from ^{14}C-ring-labeled benthiocarb. Degradation was much slower under reductive flooded conditions (fig. I) (Nakamura et al., 1977b).

When an aqueous solution of ^{14}C-benthiocarb was exposed to sunlight, volatilization of benthiocarb occurred. The presence of soil in the solution retarded the volatilization. About 60% of the volatilized radioactivity was composed of benthiocarb. Some 4-chlorobenzaldehyde was also observed (Ishikawa et al., 1977a). Irradiation by sunlight and ultraviolet light produced benthiocarb sulfoxide (II), desethyl benthiocarb (IX), 4-chlorobenzyl alcohol (XII), 4-chlorobenzaldehyde (XIII), 4-chlorobenzoic acid (XIV), 4-hydroxybenzyl alcohol (VI), 4-hydroxybenzaldehyde (VII), 4-hydroxybenzoic acid (VIII), 2-hydroxy benthiocarb (III), 4-chlorobenzyl *N*-ethylamine (XI), 4-chlorobenzyl diethylamine (X), bis(4-chlorobenzyl)sulfide (XV), 4-hydroxybenzyl ester of *N*-ethyl thiolcarbamic acid (V), 4-hydroxybenzyl ester of *N*,*N*-diethyl thiolcarbamic acid (IV), 4-chlorobenzyl *N*,*N*-diethylcarbamate (XVI), and methyl *N*,*N*-diethylcarbamate (XVII). About 20 other compounds were also detected by TLC but not identified (fig. II) (Ishikawa et al., 1977b).

Benthiocarb Irradiation


II
III
IX
IV
I
X
$CH_3O-\overset{O}{C}-N-(Et)_2$
V
XVI
XI
VI
XV
XII
XIII
VII
VIII
XIV



XII
I
VII
VIII
II
III
IX
XIV
XIII
IV
V
X
XV
VI
XI
S
P
P,M
Conj
Conj.
Glucur.

P= Plant S= Soil M= Mouse

BUTYLATE (Sutan) [S-Ethyl diisobutylthiolcarbamate]

When administered to rats, butylate yielded a glycine conjugate of the mercaptoacetic acid product that was not detected with EPTC; but the cysteine conjugate was not detected with butylate. An N-de-isobutylmercapturic acid was formed from butylate but the corresponding EPTC product was not seen (Hubbell and Casida, 1977).

DIALLATE [S-(2,3-Dichloroallyl)-N,N-diisopropylthiolcarbamate]

Diallate disappears rapidly from microbiologically active soil. About 50% of the applied dose was lost within 4 weeks. When ^{14}C-labeled diallate was applied, rapid formation of $^{14}CO_2$ was observed. The fungi Phoma eupyrena, Penicillium janthinellum, and Trichoderma harzianium degraded 20% of the diallate in 10 days (Anderson and Domsch, 1976). At temperatures between 4 and 22C, diallate loss from soil was primarily through degradation to CO_2 and binding to soil as unextractable residues. Above 22C, volatilization became increasingly important (Anderson, 1975).

EPTC (Eptam) [S-Ethyl-N,N-dipropylthiolcarbamate]

Corn seedlings, treated with EPTC or its sulfoxide, converted these compounds to the S-(N,N-dipropylcarbamoyl) GSH and cysteine conjugates (Lay et al., 1977; Lay and Casida, 1976).

In vitro studies, using a mouse liver microsome-NADPH system, were used to study EPTC degradation. Microsomal oxidation caused sulfoxidation and hydroxylation at each alkyl carbon. When conducted at physiological pH, hydroxylation α to the sulfur and nitrogen produced unstable compounds. The α-hydroxyethyl product degraded to carbonyl sulfide and acetaldehyde. The α-hydroxypropyl metabolite spontaneously decomposed to form N-depropyl-EPTC. EPTC sulfoxide formed and produced some of the sulfone. The latter can act to some extent as a carbamoylating agent for some of the liver microsome components (Chen and Casida, 1978a and b).

When applied to corn, EPTC was oxidized to the sulfoxide, conjugated with glutathione, and then cleaved to the cysteine conjugate (Hubbell and Casida, 1977). Other studies indicated that the sulfoxide reacted chemically with reduced glutathione to form the conjugate. No glutathione-S-transferase was detectable with the sulfoxide cleavage. Three other metabolites present were not identified but were probably degradation products of the conjugate. The products of acid hydrolysis of these metabolites gave a positive test for cysteine (Carringer et al., 1978).

THIRAM [Tetramethylthiuram disulfide]

In soils, sterilized or unsterilized, that have been treated with thiram, a compound was formed and identified as copper dimethyldithiocarbamate (Kumarasamy and Raghu, 1976a).

Tin Compounds

PLICTRAN (TPTOH, Tricyclohexyltin hydroxide) [Tricyclohexyl hydroxystannate]

TBTO [Tributyltin oxide]

TBTOH (Tributyltin hydroxide) [Tributyl hydroxystannate]

Bu_4Sn [Tetrabutyltin]

Bu_3SnOAc [Tributyltin acetate]

$Bu_2Sn(OAc)_2$ [Dibutyltin acetate]

Ph_3SnOAc [Triphenyltin acetate]

Biomethylation of tin appeared to follow reductive Co-C bond cleavage of alkylcobalamines.

$$SnCl_x^{2-x} + CH_3\text{-cob(III)alamin} + H_2O\text{-cob(III)alamin} \rightarrow$$

$$CH_3SnCl_y^{3-y} + 2\ \text{cob(II)alamin} + H_2O$$

(Dizikes et al., 1978)

The biological half-life of tin in mice administered labeled bis-tributyl tin oxide was calculated to be 29 days (Brown et al., 1977).

NADPH dependent metabolism of tri-n-alkyltin compounds with rabbit hepatic microsomes was in the order $Et_3SnX > Pr_3Sn > Bu_3SnX > Pen_3Sn > hex_3SnX >> Oct_3SnX$. One of the major products in each case was the corresponding dialkyl tin product. Another major metabolite was thought to be the $(\beta\text{-HOBu})Bu_2SnX$ analog. As the alkyl chain lengthened, the complexity of the metabolic pattern increased. No metabolism of Ph_3SnOAc was observed in the rabbit hepatic microsome-NADPH system (Kimmel et al., 1977).

Studies with plictran indicated degradation proceeded to inorganic tin compounds with stannic acid as the main product (Gray, 1968).

Single oral doses of tricyclohexyl ^{119}Sn-tin were administered to Wistar white rats and urine and feces were collected. Within 3 days, 63% of the label was excreted; 82% in 5 days; and 99.9% in 9 days. Residues in muscle consisted primarily of unchanged material 2 days after withdrawal. Small amounts of dicyclohexyltin oxide, cyclohexylstannoic acid, and inorganic tin were also observed. Similar studies were conducted with dogs, cattle, and sheep (Blair, 1974).

Studies were conducted with Plictran 50W. This was applied to orchard crops three to six times. Maximum levels of organotin ranged from 1.3 ppm to ∿2.5 ppm; inorganic tin, 0.3 to 1.5 ppm above controls. The presence of three organotin fractions was shown: unchanged compound, dicyclohexyltin oxide, and monocyclohexylstannoic acid and inorganic tin compounds, mainly stannic acid (Blair, 1974).

When ^{114}Sn-tricyclohexyltin hydroxide was given as single oral doses to rats, dogs, cattle and sheep, the label was excreted almost entirely in feces. Only traces of residues occurred in tissues. Evidence indicated that such metabolism as did occur converted this compound by sequential removal of cyclohexyl groups to dicyclohexyltin oxide, cyclohexylstannoic acid, and to inorganic tin (Hoerger et al., 1974).

$$SnOH \rightarrow \quad SnO \rightarrow \quad SnO_2H \rightarrow Sn^{+4}$$

^{14}C-TPTOH was administered as single oral doses to a cow, sheep and rats. The major route of excretion was via feces. The major ^{14}C-metabolites in urine were identified as hydroquinone, resorcinol, catechol and phenol and were probably present primarily as sulfate conjugates. With MS, the tin metabolites containing ^{14}C in feces were identified as $[(C_6H_5)_3Sn]_2$, $[(C_6H_5)_3Sn]_2O$, $[(C_6H_5)_3Sn]_2S$ and a series of TPTOH esters of fatty acids where $R = C_1$ to C_{30}: $(C_6H_5)_3SnO\text{-}\underset{\underset{O}{\|}}{C}\text{-}R$ (Bakke et al., 1977a).

Rat hepatic microsomal preparations were incubated with NADPH and ^{14}C-labeled organotin compounds. $[^{14}C]Bu_4Sn$ yielded eight metabolites which were identified as $(\beta\text{-HO-Bu})Bu_3Sn$ (II), $(\gamma\text{-HO-Bu})Bu_3Sn$ (III), $(\beta\text{-HO-Bu})Bu_2SnOAc$ (IV), $(\gamma\text{-HO-Bu})Bu_2SnOAc$ (V), $(\delta\text{-HO-Bu})Bu_2SnOAc$ (VI), Bu_3SnOAc (VII), $Bu_2Sn(OAc)_2$(VIII), and 1-butene (IX). The tributyltin acetate (VII) degraded to give compounds IV, V, VI, VIII, $(\gamma\text{-C=O-Bu})Bu_2SnOAc$, and IX. The dibutyltin acetate (X) yielded only $BuSn(OAc)_3$. Similar results were obtained with $[^{14}C]Bu_3SnOAc$ and $[^{14}C]Bu_2Sn(OAc)_2$ when administered to mice. $^{14}CO_2$ was also observed in vivo with mice (Kimmel et al., 1977).

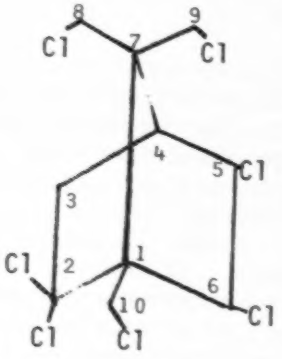
TOXAPHENE [Camphene chlorinated to 67-69% chlorine by weight and an average $C_{10}H_8Cl_{10}$ composition]

In vitro studies were conducted with rat liver microsomal preparations. Metabolism of toxaphene was increased by addition of GSH and NADPH. In addition to dechlorination, some oxidation to hydroxy and acidic compounds occurred. None were identified (Chandurkar and Matsumura, 1977). Further study showed that aglycones were released by the action of β-glucuronidase and β-sulfatase, indicating the presence of water-soluble conjugates in vitro. UDPGA-glucuronyl transferase also released water-soluble products. GC analyses indicated the formation of 24 new compounds when GSH was added and 49 with NADPH versus 16 in the controls. A large part of the metabolites were hydroxyl compounds. When nonachlorobornane (toxicant C), a component of toxaphene was used as a substrate, products identified were octachlorobornane, and the five products of hydroxylation at carbons 2, 3, 4, 6 and at the bridge head methyl. Toxicant B, another toxaphene component, produced five non-hydroxylated metabolites. Water-soluble glutathione conjugates formed in vitro. In vivo, metabolic products appeared to be more polar indicating more complete metabolism (Chandurkar, 1978).

In rats orally treated with toxaphene, fat contained materials similar in GLC characteristics to toxaphene itself. Liver and feces contained toxaphene products that exhibited greatly altered GLC characteristics. One of the most toxic components of toxaphene, identified as 2,2,5-endo,6-exo,8,9,10-heptachlorobornane (I) was reductively dechlorinated to give compounds II and III in the following systems: UV photolysis in hexane; reaction with triphenyltin hydride, reduced hematin, bovine rumen fluid, sewage primary effluent, an anaerobic liver microsome-NADPH system. Rats and houseflies also were able to cause this reaction in vivo. Triphenyltin hydride, reduced hematin and rats and houseflies in vivo also produced compound IV. Compound V was produced by the hematin system. Identification of the products was made by NMR, CIMS and X-ray (Saleh and Casida, 1978a,b and c).

A rat liver microsome-NADPH system converted toxaphene toxicants A and B under anaerobic conditions to two major metabolites and three to seven other products. Fewer metabolites were observed under aerobic conditions. None were identified (Khalifa et al., 1976).

Toxaphene reacted with iron (II) protoporphyrin and underwent extensive dechlorination and conversion to products with shorter GC retention times. Toxaphene toxicants A and B also were reacted with reduced hematin. With toxicant A ($C_{10}H_{10}Cl_8$), this produced two reductive dechlorination products ($C_{10}H_9Cl_7$), two products corresponding to $C_{10}H_{10}Cl_6$, and other material not characterized. Toxicant B ($C_{10}H_{11}Cl_7$) produced two reductive dechlorination products


8
9
Cl
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5
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1
6
10
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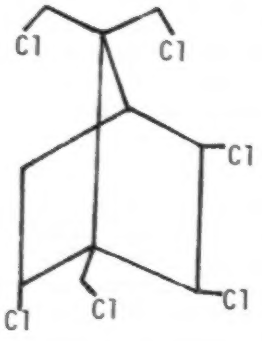
I


Cl
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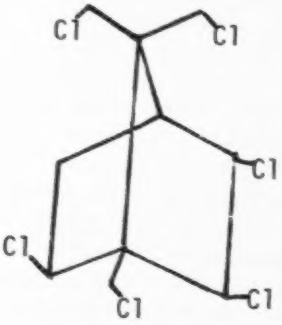
II

+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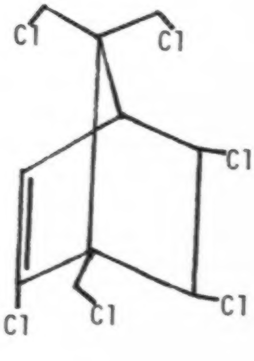
III

+


Cl
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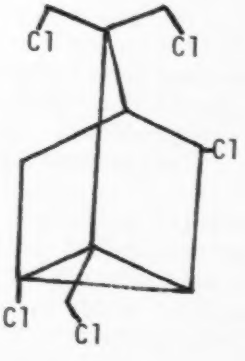
IV

+


Cl
Cl
Cl
Cl
Cl

V

($C_{10}H_{12}Cl_6$), one dehydrochlorination product ($C_{10}H_{10}Cl_6$), two products corresponding to $C_{10}H_{11}Cl_5$, and three other products with GC retention times longer than the starting material but not further characterized (Khalifa et al., 1976).

Nine fractions of toxaphene were incubated in flooded Matapeake silt loam for 42 days under anaerobic conditions. Some CO_2 was produced. The primary reaction was reductive dechlorination (Murthy et al., 1977).

In a moist anaerobic soil, there was little toxaphene degradation unless amended with an energy source such as alfalfa meal. Microbiological involvement was demonstrated (Parr and Smith, 1976).

Toxaphene degraded rapidly in sterile and nonsterile estuarine sediment. The chemical nature of this reaction was apparent from the reaction in sterile sediment and in sand containing a Fe (II)/Fe (III) redox couple. No breakdown occurred in the sand control system (Williams and Bidleman, 1978).

UV irradiation (168 h and λ 230 nm) of technical toxaphene and two components--2-*endo*,6-*endo*-dichlorbornane and 2-*exo*-10-dichlorobornane adsorbed on Kieselgel--produced CO_2 and HCl (Parlar et al., 1976).

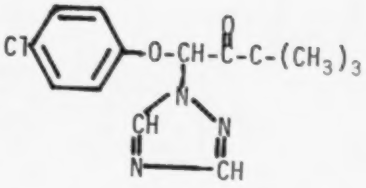
TRIADIMEFON (Ethylan) [1-(4-Chlorophenoxy)-3,3-dimethyl-1-(1,2,4-triazol-1-yl)butanone]

Triadimefon was applied to vigorously growing marrow plants. Within 5 days, 56% had been converted to two compounds which were identified after separation and analyses by IR, MS, PMR and comparison with authentic samples as the diastereoisomeric secondary alcohols of II (Clark et al., 1978).

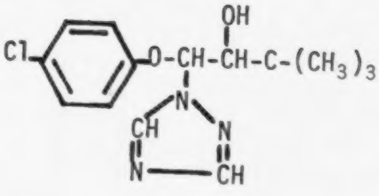
Triadimefon was applied to cucumber, tomato, bean and wheat plants and incubated with leaf homogenates of these plants. Differences were primarily quantitative. Triadimenol, the 2-butanol analog, was formed in each case (Gasztonyi and Josepovits, 1978).

In shake culture with *Aspergillus niger*, I was reduced to II but, when incubated with mycelial mats of fungi, a different metabolic pattern was observed. Some conversion to II occurred (4%) but a much larger (up to 32%) amount was converted to a compound believed to be the isopropyl analog III (Clark et al., 1978).

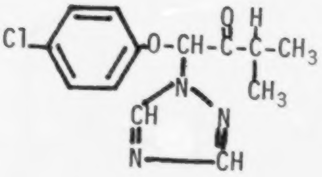
Photolysis of I gave a yellow oily residue. The major component was identified after GLC-MS, IR, and PMR as 4-chlorophenyl methyl carbonate. Other minor compounds were identified as 4-chlorophenol and 1,2,4-triazole (Clark et al., 1978).



I



II



III

TRIAZINES

When 4-amino-6-R-3-methylthio-*as*-triazin-5-(4H)-ones (where R=isopropyl, butyl or cyclohexyl) were photolyzed in CCl_4, benzene, methanol or water, the major product was the respective 5-hydroxy-1,2,4-triazine. Similar results were obtained with photolysis in the crystalline state. Desulfurization and oxidation also occurred (Pape, 1975).

2-Fluoro- and 2-bromo-4,6-bis(ethylamino)-*s*-triazine photolysis in methanol and water at 253.7 and 300 nm produced the 2-methoxy and 2-hydroxy analogs. Photolysis of the 2-iodo analogs of atrazine, simazine and propazine in methanol, ethanol and *n*-butanol at 300-360 nm produced respective 2-alkoxy derivatives as the major products. When 2-azido-4-ethylamino-6-methylthio-*s*-triazine was used, the 2-amino-4-ethylamino- and 2-azido-4-ethylamino-*s*-triazines were formed (Pape, 1975).

In acetone-water, 2,4-dichloro-6-methoxy-*s*-triazine reacted with amines or amino acids to replace chlorine. With careful addition of NaOH to neutralize released HCl, the chlorines can be selectively replaced (Grudzinski and Gniadek, 1977). Photochemical stability of triazines in aqueous acetone solutions increased in the order methylthio- < chloro- < methoxy-*s*-triazines. When atrazine, ametryne and atraton were used, photoproducts included the analogous two *N*-dealkyl and the *N*,*N*'-didealkyl derivatives and the corresponding hydroxytriazines. Irradiation of ametryne also yielded de-methylthio-*s*-triazines. Results are summarized in the following table (Burkhard and Guth, 1976).

Compound	Photoproducts observed		
	R_1	R_2	R_3
Atrazine	Cl	H	Pr (1)
	Cl	Et	H
	Cl	H	H
Ametryne	SMe	H	Pr (1)
	SMe	Et	H
	SMe	H	H
Atraton	OMe	H	Pr (1)
	OMe	Et	H
	OMe	H	H
	H	Et	Pr
	H	H	Pr
	H	Et	H
	H	H	H

Compound	Photoproducts observed		
	R_1	R_2	R_3
Atraton			
	OH	Et	Pr
	OH	H	Pr
	OH	Et	H
	OH	H	H

(1) Solvent system: $CHCl_3/CH_3OH/HCOOH/H_2O$(80+15+4+2)

Microorganisms, isolated from soils treated with triazines over many years, rapidly metabolized N-isopropyl(or ethyl)ammeline to the respective N-alkylammelide, ammeline to cyanuric acid, and cyanuric acid to CO_2 (Zeyer et al., 1978a and b).

ATRAZINE [2-Chloro-4-ethylamino-6-isopropylamino-_s_-triazine]

Atrazine was fed to white leghorn hens for 7 days. No residues of atrazine or its metabolites were found in eggs. In collected excreta, atrazine, desethylatrazine, 2-hydroxyatrazine, and 2-hydroxy-desethylatrazine were present (Foster and Khan, 1976). Analyses of chicken tissues indicated the presence of hydroxyatrazine, desethylhydroxyatrazine and desethylatrazine. Highest levels of hydroxy- and desethylhydroxyatrazine were in the liver. GC/MS was used to identify metabolites (Khan and Foster, 1976).

Redroot pigweed was shown to hydroxylate atrazine. Corn extensively degraded atrazine by hydrolysis, _N_-dealkylation and glutathione conjugation. Dealkylation of hydroxyatrazine by sorghum was also observed. Oats, soybeans and sorghum conjugated atrazine to a limited extent (Thompson, 1975).

Atrazine applied to marsh grass, _Spartina alterniflora_, was readily absorbed by roots and translocated to the shoots. Atrazine was metabolized to chloroform, aqueous and insoluble substances. In addition to unchanged atrazine, dealkylation products present were identified as desethylatrazine, desisopropylatrazine, and 2-chloro-4,6-diamino-_s_-triazine (Pillai et al., 1977a).

About 53 grass species of the subfamilies Festucoideae, Panicoideae and Eragrostoidea (Gramineal subfamilies) were exposed to atrazine. _N_-Dealkylation, hydroxylation and peptide conjugation occurred in all species. _N_-Desethylatrazine, _N_-desisopropylatrazine and glutathione and glutamylcysteine conjugates were the predominant metabolites in panicoid grasses. Hydroxyatrazine was observed in _Dicanthum supercillatum_ and _Zea mays_ (Jensen, 1976; Jensen et al., 1977b).

In crabgrass and witchgrass, the major hydrophilic metabolites of atrazine were peptide conjugates believed to be S-(ethylamino-6-isopropylamino-2-_s_-triazino)glutathione and/or glutamyl-S-(4-ethylamino-6-isopropylamino-2-_s_-triazine)cysteine. There were also traces of hydroxyatrazine and other unidentified metabolites (Robinson and Greene, 1976).

There was no difference in uptake, translocation or metabolism of atrazine by resistant and susceptible lamb's quarters (_Chenopodium album_ L.). Hydroxylation, _N_-dealkylation and peptide conjugation was observed. Metabolites identified included hydroxyatrazine, desethylatrazine, desisopropylatrazine, S-(4-ethylamino-6-isopropylamino-_s_-triazinyl-2)glutathione, and S-γ-L-glutamyl-(4-ethylamino-6-isopropylamino-_s_-triazinyl-2)-L-cysteine (Jensen et al., 1977a).

After application in 9 consecutive years in a peach orchard soil, atrazine persisted for some years afterwards. Oats were then grown in the treated plots, after removal of the trees, and in soil from the treated plots. Roots, shoots and soil samples contained hydroxyatrazine, desethylhydroxyatrazine, and desisopropylhydroxyatrazine. In addition to these compounds, soil contained residues of desisopropylatrazine and desethylatrazine. Oats converted hydroxyatrazine, taken up from soil, to a conjugated form. This was also observed with the dealkylated hydroxyatrazine derivatives. GC/MS was used to identify the metabolites (Khan and Marriage, 1977a and b).

Atrazine was applied to plots having tile drains. Corn was grown in these plots and water samples were collected from the tile outlets. Analyses of the water, using GC and several different detectors and columns, indicated the presence of deethylated atrazine and desisopropylatrazine. Some hydroxyatrazine was observed in the soil (Muir and Baker, 1976 and 1978).

A Bladen silt loam (pH 5.5) was modified with lime to pH 7.5. Atrazine degraded nonbiologically and the major isolate was identified as hydroxyatrazine. After 5 months, 35% of the added atrazine was extractable from the soil at pH 7.5 but only 11% from pH 5.5 soil (Best, 1974).

Montmorillonite and montmorillonitic Coker soil clay were saturated with H^+, Al^{3+}, Cu^{2+} and Ca^{2+}. Hydrolysis of atrazine was promoted by H^+ and Al^{3+} but not by Ca^{2+} or Cu^{2+} (Skipper et al., 1978). Heating of clay-aluminum systems also increased hydrolysis of adsorbed atrazine (Terce et al., 1977). In other studies, atrazine persistence increased with increasing pH (Hiltbold and Buchanan, 1977).

In aqueous fulvic acid solution, atrazine hydrolysis followed first-order kinetics. The only product identified was the hydroxyatrazine (Khan, 1978).

In ethanolic 6N HCl, atrazine was hydrolyzed to nonphytotoxic hydroxyatrazine (Skipper et al., 1976).

CP-25415 [2-[3-Chloro-4-(4-chlorobenzoyl)phenyl]-*as*-triazin-3,5-(2H,4H)-dione]

Chickens, administered CP-25415 by gavage, metabolized this compound to 2-[3-chloro-4-(4-chloro-α-hydroxybenzyl)phenyl]-*as*-triazin-3,5-(2H,4H)-dione (CP-25641). Identification of the metabolite was confirmed by MS. Reduction to the alcohol was rapid and CP-25641 was the only metabolite found in plasma, tissue and excreta. The half-lives in tissues and kidney were about 32 and 40 h, respectively (Rash and Lynch, 1976).

TRIAZINES

CYANATRYN (WL 63611) [2-(1-Cyano-1-methylethylamino)-4-ethylamino-6-methylthio-*s*-triazine]

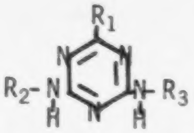
Post-mitochondrial supernatant (10000g) from male rat liver converted cyanatryn primarily to the *N*-de-ethyl and GSH derivatives. Another metabolite was identified as the S-oxide of cyanatryn. Metabolites were identified by chromatographic and isotope dilution procedures (Bedford et al., 1975a). In urine of rats fed cyanatry, the 6-mercapturic acid derivative of cyanatryn was observed (Crawford et al., 1975).

TRIAZINES

CYANAZINE [2-Chloro-4-(1-cyano-1-methylethylamino)-6-ethylamino-*s*-triazine]

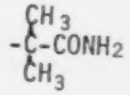
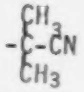
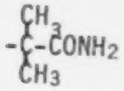
Redroot pigweed did not hydroxylate cyanazine but did conjugate this compound. In corn, hydrolysis, *N*-dealkylation and glutathione were observed. The hydroxy-acid and dealkylated hydroxy-acid were observed in corn. Presence of the carboxyl group on the isopropylamino side chain suppressed dealkylation of the ethylamino group (Thompson, 1975).

Fall panicum and green foxtail contain water- and chloroform-soluble metabolites 5 days after foliar ^{14}C-cyanazine application. The nitrile group was hydrolyzed and the triazine two position was hydroxylated. Metabolites observed are summarized in the following table (Kern et al., 1976).



1 = Fall panicum
2 = Green foxtail
3 = Corn

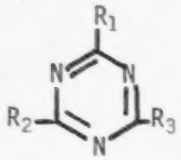
R_1	R_2	R_3	Plant
Cl	$-\overset{CH_3}{\underset{CH_3}{C}}-CN$	C_2H_5	
OH	$-\overset{CH_3}{\underset{CH_3}{C}}-COOH$	H	1,2,3
OH	$-\overset{CH_3}{\underset{CH_3}{C}}-COOH$	C_2H_5	1,2,3
OH	H	C_2H_5	1,3
OH	H	H	
Cl	$-\overset{CH_3}{\underset{CH_3}{C}}-COOH/-\overset{CH_3}{\underset{CH_3}{C}}-CONH_2$	C_2H_5/H	3
Cl	$-\overset{CH_3}{\underset{CH_3}{C}}-CN$	H	1,2,3

R	R	R	Plant
Cl	 $-\overset{CH_3}{\underset{CH_3}{C}}-CONH_2$	C_2H_5	1,2,3
OH	 $-\overset{CH_3}{\underset{CH_3}{C}}-CN$	C_2H_5	1,2
Cl	 $-\overset{CH_3}{\underset{CH_3}{C}}-CONH_2$	H	1,2
Cl	H	C_2H_5	2,3

Cyanazine was applied to plots having tile drains. Corn was grown i these plots and water samples were collected from the tile outlets. Analyses of the water, using GLC and several different detectors and columns, indicated the presence of cyanazine amide in addition to unchanged cyanazine. Some hydroxycyanazine was observed in the soil (Muir and Baker, 1976).

DIMETHAMETRYN (Avirsan, C 18898) [2-(1,2-dimethylpropylamino)-4-ethylamino-6-methylthio-s-triazine]

^{14}C-Ring-labeled dimethametryn was applied to rice paddy water under greenhouse conditions. At maturity of rice grown in the paddy water, leaves and grains both contained radioactivity. In addition to parent material, metabolites observed in leaves were identified by spectroscopy or cochromatography as: N-deethyl dimethametryn (II); the hydroxy dimethylpropyl derivatives (III and IV); the desmethylthio analog (V): 2,4-diamino-6-(1,2-dimethylpropylamino)-s-triazine (VI); 2-ethylamino-4-(1,2-dimethylpropylamino)-6-hydroxy-s-triazine (VII); and 2-amino-4-(1,2-dimethylpropylamino)-6-hydroxy-s-triazine (VIII). Some metabolites were characterized as amino acid conjugates but not further identified. Soil analyses showed the presence of: parent compound; metabolites II, III, IV, VII and VIII; dimethametryn sulfoxide (IX); 2-(1,2-dimethyl-2-hydroxypropylamino)-4-ethylamino-6-hydroxy-s-triazine (X); and 2-(1,2-dimethyl-3-hydroxypropylamino)-2-ethylamino-6-hydroxy-s-triazine (XI) (Mayer, 1978).



Compound	R1	R2	R3
I	$S\text{-}CH_3$	$\overset{H}{N}\text{-}CH_2\text{-}CH_3$	$\overset{H}{N}\text{-}\underset{CH_3}{CH}\text{-}\underset{CH_3}{CH}\text{-}CH_3$
II	$S\text{-}CH_3$	NH_2	$\overset{H}{N}\text{-}\underset{CH_3}{CH}\text{-}\underset{CH_3}{CH}\text{-}CH_3$
III	$S\text{-}CH_3$	$\overset{H}{N}\text{-}CH_2\text{-}CH_3$	$\overset{H}{N}\text{-}\underset{CH_3}{CH}\text{-}\underset{CH_3}{\overset{OH}{C}}\text{-}CH_3$
IV	$S\text{-}CH_3$	$\overset{H}{N}\text{-}CH_2\text{-}CH_3$	$\overset{H}{N}\text{-}\underset{CH_3}{CH}\text{-}\underset{CH_3}{CH}\text{-}CH_2OH$

Compound	R_1	R_2	R_3
V	NH_2	$\overset{H}{N}\text{-}CH_2\text{-}CH_3$	$\overset{H}{N}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}CH_3$
VI	NH_2	NH_2	$\overset{H}{N}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}CH_3$
VII	OH	$\overset{H}{N}\text{-}CH_2\text{-}CH_3$	$\overset{H}{N}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}CH_3$
VIII	OH	NH_2	$\overset{H}{N}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}CH_3$
IX	$\overset{O}{\overset{\|}{S}}\text{-}CH_3$	$\overset{H}{N}\text{-}CH_2\text{-}CH_3$	$\overset{H}{N}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}CH_3$
X	OH	$\overset{H}{N}\text{-}CH_2\text{-}CH_3$	$\overset{H}{N}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}\overset{OH}{\underset{\substack{C\\H_3}}{C}}\text{-}CH_3$
XI	OH	$\overset{H}{N}\text{-}CH_2\text{-}CH_3$	$\overset{H}{N}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}\underset{\substack{C\\H_3}}{CH}\text{-}CH_2OH$

METHAMITRON [4-Amino-3-methyl-6-phenyl-1,2,4-triazin-5(4H)-one]

A variety of soil microorganisms was able to metabolize metamitron in the presence of a second carbon source. Strains of *Arthrobacter*, *Pseudomonas*, *Rhizopus japonicus* ATCC 2474 and *Cunninghamella echinulata* Thaxter produced desaminometamitron (Engelhardt and Wallnofer, 1978).

At 10.5% soil moisture, the half-life of metamitron in sandy loam soil varied between 91 days (4C) and 9.8 days (30C) (Bond and Roberts, 1976).

METRIBUZIN (Sencor) [4-Amino-6-t-butyl-3-methylthio-as-triazin-5(4H)-one]

When ^{14}C-metribuzin was applied to tomatoes, preliminary evidence indicated that the first ^{14}C-metabolite may be a complex with deaminated diketo metribuzin or metribuzin (Stephenson et al., 1974 and 1976).

Metribuzin applied to roots of soybean [*Glycine max* (L.) Merr. 'Cutler'] seedlings was rapidly absorbed and translocated to the shoots. The major product observed was deaminated metribuzin (DA). The 3,5-diketo (DK) and deaminated diketo (DADK) derivatives were also observed. Identity of these metabolites was determined by cochromatography and MS. Roots and shoots both produced these compounds. The aglycones of four acid labile carbohydrate conjugates formed were identified as DK and DADK (Mangeot et al., 1976; Schumacher, 1974; Schumacher et al., 1974).

Potatoes were planted in soil treated with metribuzin. Analyses of plant material showed the presence of DA, DK and DADK as well as conjugated material. Analyses indicated that DADK was the aglycone of one conjugate. When these studies were repeated in the same soil, another metabolite was found in the top part of the plants and identified as trimethylpyruvic acid semicarbazone. Similar results were observed with carrots and the soil in which these plants had been grown. TLC, GLC and GLC/MS were used to identify the metabolites (Prestel et al., 1976).

In mineral and muck soils, metribuzin metabolism via deamination and thiodealkylation produced: 6-(1,1-dimethylethyl)-3-methylthio-1,2,4-triazin-5-(4H)-one (DA); 4-amino-6-(1,1-dimethylethyl)-1,2,4-triazin-3,5-(2H,4H)-dione (DK); and 6-(1,1-dimethylethyl)-1,2,4-triazin-3,5-(2H,4H)-dione (DADK) (Waggoner et al., 1974). Over a pH range of 4.5 to 6.9 in sandy clay loam, microbial degradation gave $^{14}CO_2$ from ^{14}C-ring-labeled metribuzin. It was also observed that metribuzin degradation by soil microorganisms decreased with increasing soil pH (Ladlie et al., 1974 and 1976a and b).

In soil, metribuzin was degraded to CO_2. Autoclaving of soil decreased metribuzin metabolism. Those metabolites observed in plants--DA, DK and DADK--were also observed in the soil. DADK was the primary metabolite in soil (Schumacher, 1974).

Metribuzin, applied in June to a fine sandy loam soil, degraded during the growing season to the extent that less than 10% of applied herbicide was present by October 25, freeze-up time. DA, DK and

DADK were observed in soil samples and metabolite residue levels were at their maximum near the middle of July (Webster and Reimer, 1976a).

In a study with Guelph loam, the half-life of metribuzin was about 3 months (Sharom and Stephenson, 1976). Under greenhouse conditions with soils from the lower alluvial floodplain of the Mississippi River, metribuzin half-life varied from 17 to 28 days and followed first-order kinetics (Savage, 1977). In four Manitoba soils under dry conditions at 15C, some nonbiological degradation of metribuzin occurred. The rate law was somewhat less than first-order and half-lives varied from 90 to 115 days (Webster et al., 1978). Field soil samples awaiting analysis underwent degradation. At -37C, about 50% of the herbicide could be lost in 282 days. DK and DADK also degraded under storage conditions (Webster and Reimer, 1976b).

In laboratory studies with a sandy loam soil, metribuzin calculated half-life was about 329, 44 and 16 days at 5, 20 and 35C, respectively. DA and DADK were observed (Hyzak, 1973).

Photolysis of metribuzin in methanol yielded 6-t-butyl-5-hydroxy-3-methylthio-*as*-triazine, DK, DADK and methylsulfonic acid. In acetone in addition to these compounds, a condensation product observed was identified as 6-*t*-butyl-4-isopropylidenamino-3-methylthio-*as*-triazin-5-(4H)-one. Product identification utilized IR, NMR and UV (Bartl and Korte, 1975a and b).

TRIAZINES

PROMETRYN [2,4-Bis(isopropylamino)-6-methylthio-s-triazine]

The soil bacterium Agrobacterium radiobacter metabolized prometryn to yield 2-ethylamino-4-isopropylamino-6-methylthio-s-triazine and 2-amino-4-isopropylamino-4-methylthio-s-triazine. Identification of these metabolites was made by UV, melting point and chromatographic comparisons (Giardina and Buffone, 1977).

Changes in soil moisture had a profound effect on prometryn disappearance. At 25C prometryn $t_{1/2}$ varied from 30 days at 14% soil moisture to 590 days at 5% soil moisture (Walker, 1976).

A Bladen silt loam (pH 5.5) was modified by liming to pH 7.5. Added prometryn was degraded biologically to an unknown plus the 6-hydroxy derivative (Best, 1974).

SIMAZINE [2,4-Bis(ethylamino)-6-chloro-*s*-triazine]

Yellow poplar (*Liriodendron tulipifera* L.) and black walnut (*Juglans nigra* L.) dealkylated simazine. In addition to the monodealkylated simazine, the di-dealkylated 2-chloro-4,6-diamino-*s*-triazine was observed in yellow poplar and black walnut roots. Hydroxysimazine was also observed in yellow poplar roots but not in black walnut extracts (Wichman, 1973).

In sandy loam soil, simazine $t_{1/2}$ varied from 37 days at 25C and 13% soil moisture to 234 days at 15C and 7% soil moisture (Walker, 1976).

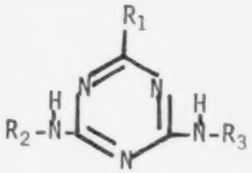
TRIAZINES

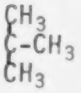
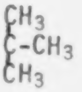
TERBUTRYNE [2-(*t*-Butylamino)-4-ethylamino-6-methylthio-*s*-triazine]

After administration of terbutryn (I) to rats, urinary metabolites observed and identified by MS of trimethylsilyl derivatives included: 2-hydroxy terbutryn (VIII); 2-amino-4-hydroxy-6-*t*-butylamino-*s*-triazine (VII); 2-amino-4-*t*-butylamino-6-mercapto-*s*-triazine (IX); two S-glucuronides and two *t*-butyl-*O*-glucuronides. Other metabolites were formed by one or a combination of the following reactions: *N*-alkyl oxidation to alcohols or acids; S-demethylation; *N*-deethylation; and disulfide formation (Larsen and Bakke, 1974).

C-Labeled terbutryn (I) was administered as single oral doses to rats and goats. Urine was collected at intervals up to 72 h and then analyzed by MS after isolation of glucuronides by chromatographic procedures. Five conjugates isolated and identified were: 2-amino-4-(*t*-butylamino)-6-(S-glucuronyl)-*s*-triazine (III); 2-(*t*-butylamino)-4-ethylamino-6-(S-glucuronyl)-*s*-triazine (II); 2-ethylamino-4-[2-(2-methyl)glucuronylpropyl]amino-6-(S-methylthio)-*s*-triazine (V); 2-amino-4-[2-(1-glucuronyl-2-methylpropyl)amino]-6-methylthio-*s*-triazine (VI); 2-ethylamino-4-[2-(2-methyl propan-1-olyl)amino]-6-(S-glucuronyl)-*s*-triazine (IV) (Larsen and Bakke, 1978).

In soil at about neutral pH, only humic acids adsorb terbutryne. The effect of pH on terbutryne adsorption by humic acids and Ca-montmorillonite, or mixtures of the two, exhibited a similarity to that of clay alone (Gaillardon et al., 1977).



Compound	R_1	R_2	R_3
I	$S-CH_3$	C_2H_5	 $\overset{CH_3}{\underset{CH_3}{C-CH_3}}$
II	S-Gluc.	C_2H_5	 $\overset{CH_3}{\underset{CH_3}{C-CH_3}}$

Compound	R_1	R_2	R_3
III	S-Gluc.	H	CH_3 $C-CH_3$ CH_3
IV	S-Gluc.	C_2H_5	CH_3 $C-CH_2OH$ CH_3
V	S-CH_3	C_2H_5	CH_3 $C-CH_2O$-Gluc CH_3
VI	S-CH_3	H	CH_3 $C-CH_2O$-Gluc CH_3
VII	OH	H	CH_3 $C-CH_3$ CH_3
VIII	OH	C_2H_5	CH_3 $C-CH_3$ CH_3
IX	SH	H	CH_3 $C-CH_3$ CH_3
X	S-CH_3	H	CH_3 $C-CH_3$ CH_3
XI	SH	C_2H_5	CH_3 $C-CH_3$ CH_3

TIAZURIL [2-[4-(4-Chlorophenylthio)-3,5-xylyl]-*as*-triazin-3,5(2H,4H)-dione]

Following oral administration of tiazuril to chickens, analyses indicated sulfur metabolism to produce the sulfoxide (T-SO) and sulfone (T-SO_2). The chlorophenyl ring was hydroxylated and yielded hydroxytiazuril (HO-T), HO-T sulfoxide (HO-T-SO) and HO-T sulfone (HO-T-SO_2). GLC-MS was used to identify the metabolites. In dogs only possible traces of the hydroxy derivatives were observed. Results of these studies are summarized (Lynch and Figdor, 1977).

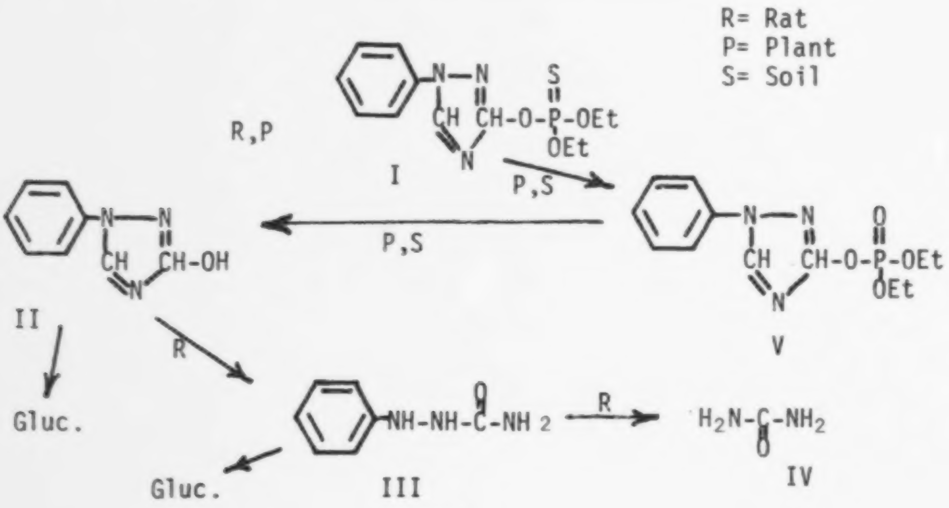
Animal	Source	Metabolite			
		T-SO/T-SO_2	HO-T	HO-T-SO	HO-T-SO_2
Chicken	Excreta	+	+	+++++	++
Rat	Feces	+	+	+++	++++
	Urine	ND	ND	ND	ND
Dog	Feces	+	ND	ND	ND
	Urine	ND	ND	ND	ND
	Bile	++++	±	±	±

TRIAZOPHOS (Hostathion) [O,O-Diethyl O-3-(1-phenyl-1,2,4-triazolyl) phosphorothionate]

^{14}C-Triazophos, dissolved in oil, was administered to white rats in single and repeated doses. When given as a single dose, 76% of the applied label was excreted within 4 days in urine and 21% in feces. When given repeatedly on 12 consecutive days, 69 to 83% of the daily applied label was excreted in urine and 18 to 30% in feces. The feces contained unchanged triazophos and the hydrolysis product 1-phenyl-3-hydroxy-1,2,4-triazole (II). The urine contained ^{14}C-urea, II-glucuronide, phenylsemicarbazide glucuronide, and semicarbazide glucuronide. Identification of metabolites was made with TLC, IR and MS. Two other metabolites were observed but not identified. Neither triazophos nor the oxon analog were observed in urine (Bock and Thier, 1976; Bock et al., 1974).

In plants to which triazophos had been applied, the residues at harvest consisted mainly of unchanged triazophos plus 1-phenyl-3-hydroxy-1,2,4-triazole (1/5 of the total residue), and traces of the P=O analog of triazophos. Fifteen weeks after application of triazophos to cotton, residues consisted of triazophos (0.02 ppm), compound II (0.01 ppm), and an unidentified compound (0.01 ppm). The latter was probably a desethyl analog. Similar results were obtained with beans and rice (Bock et al., 1974).

Triazophos degradation was studied in nine soils. In two different standard German soils, the $t_{1/2}$ was calculated to be about 18 days and about 87 days. In nearly all soils, three unidentified compounds and traces of the hydroxytriazole occurred rapidly and in amounts of 1-6% of the initial radioactivity. $^{14}CO_2$ was also recovered. In the field, two soils were treated. After 90 days, TLC revealed the presence of metabolites which behaved like compounds II, IV and V (Bock et al., 1974).



3,4,5-Tribromo-*N*,*N*,α-trimethylpyrazole-1-acetamide

The title compound, when orally administered to rats, was metabolized rapidly and 90% of the dose was excreted within 72 h (75-80% in urine). Four metabolites were observed and identified by GC-RAM and GC-MS: 3,4,5-tribromo-*N*,α-dimethylpyrazole-1-acetamide; 3,4,5-tribromo-α-methylpyrazole-1-acetamide; 3,4,5-tribromo-α-methylpyrazole-1-acetic acid; and 3,4-dibromo-α-methylpyrazole-1-acetic acid (Hornish and Nappier, 1977 and 1978).

TRICLOPYR (Garlon) [3,5,6-Trichloro-2-pyridinyloxyacetic acid]

Metabolism of triclopyr by grass consisted almost entirely of conjugation (Johnson et al., 1976).

TRIDEMORPH (Calixin) [*N*-Tridecyl-2,6-dimethylmorpholine]

Sprague-Dawley adult CFY rats were orally dosed by intubation with ^{14}C-tridemorph in corn oil. Absorption was rapid. The ^{14}C-half-life in the rats was about 15 h. Within 5 days, more than 40% of the dose was excreted in urine and in feces. Less than 2% was expired. Urine, bile and feces contained metabolites more polar than tridemorph. The major urinary metabolite was believed to be hydroxylated in the tridecyl chain. Three other metabolites were observed but not identified. There was no evidence of glucuronides (Hawkins et al., 1974).

When applied to barley plants, a portion of the tridemorph was bound firmly to plant tissue (Waring and Wolfe, 1975).

TRIFORINE (Cela W 524) [1,1'-Piperazine-1,4-diyldi-*N*-(2,2,2-trichloroethylformamide]

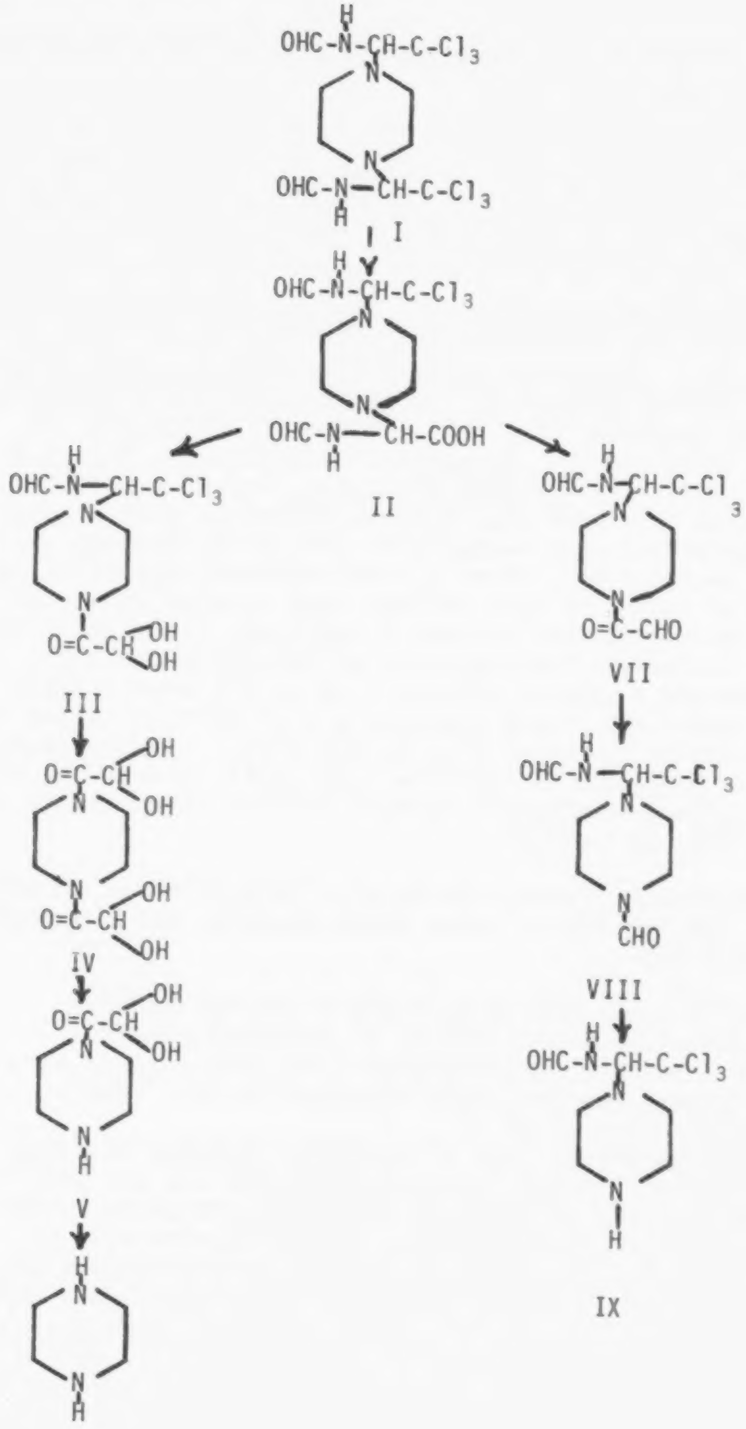
Triforine was administered orally to a rat. Analyses indicated excretion of four compounds. One of two major compounds excreted in urine was identified by MS as *N*-(2,2,2-trichloro)-1-[(piperazin-1-yl)ethyl]formamide (VIII) (Darda, 1977).

Metabolism of triforine varied between plant species. In bean and barley leaves, half the triforine broke down in 35 days; in tomato leaves, ca. 10 days. Triforine was converted nearly quantitatively to one metabolite, not identified. In barley seedlings a number of metabolites were observed. One was identified as piperazine (VI) (Fuchs et al., 1976a and b). In addition to piperazine, *N*-(2,2,2-trichloro)-1-[(piperazin-1-yl)ethyl]formamide, iminodiacetic acid, glycine and oxalic acid were also observed in barley plants. When shoots of barley plants root-treated with $[^3H]$-triforine were extracted with methanol-HCl, after previous methanol extraction, an additional 18% of triforine type residues were obtained as VI and VIII bound residues. Another portion of the labeling was found in DMSO extract. Successive hydrolysis by amyloglucosidase and β-glucosidase produced a complex mixture of polar and water soluble products not identified. These probably were products of extensive triforine degradation and incorporation into starch. Barley grown in the field and treated with triforine also contained residues of piperazine and piperazine-containing bound residues (Rouchaud et al., 1977a and d; 1978a, b, c and d).

Bean and tomato seedlings were treated with $[^3H]$triforine. In addition to piperazine, the presence of three other compounds was indicated (Fuchs and Ost, 1976).

When irradiated in water with Hanan Q-300 or RUL-300 nm lamps, triforine was transformed to a mixture of unchanged piperazine, glycine and three unidentified compounds. The same products were observed when sensitizers were added (Rouchaud et al., 1978e).

In aqueous buffer solutions, half of triforine degraded in 2 days. In the range of pH 4.7 to 9.2, the hydrolysis rate was not significantly dependent on pH. Products of hydrolysis are shown in the following proposed hydrolytic pathway. MS and TLC were used to identify compounds II, III, IV, V, VI and VII and comparative TLC for compounds VIII and IX (Darda et al., 1977; Fuchs and Ost, 1976).



I

II

III

IV

V

VI

VII

VIII

IX

OHC-N-CH-C-Cl3
OHC-N-CH-COOH
O=C-CH
OH
O=C-CHO
CHO
N
H

TSUMACIDE [N-Methyl m-tolylcarbamate]

Male and female rats were treated orally with ^{14}C-tsumacide. No $^{14}CO_2$ was detected in expired air. Urine analysis showed the presence of m-carboxy tsumacide. This accounted for almost 60% of the ^{14}C excreted. Other metabolites observed included m-hydroxymethyl tsumacide, 4-hydroxy tsumacide, m-hydroxybenzoic acid and m-cresol. More than 50% of the water-soluble metabolites were cleaved by acid. β-Glucuronidase cleaved water phase conjugates to produce m-CH_2OH-tsumacide, m-COOH-tsumacide and 4-OH-tsumacide. m-Cresol was produced by incubation with aryl sulfatase. Incubation of ^{14}C-tsumacide with microsomes from rabbit, rat and mouse livers in the presence of NADPH produced 4-hydroxy and m-hydroxymethyl tsumacide (Ohkawa et al., 1974b).

^{14}C-Tsumacide was applied topically to houseflies. In the water-excreta fraction, N-hydroxymethyl tsumacide, m-hydroxymethyl tsumacide, m-carboxyl tsumacide and 4-hydroxy tsumacide were observed. The same metabolites were formed internally. Methanol soluble products were hydrolyzed by β-glucuronidase and β-glucosidase, indicating the presence of m-COOH-tsumacide as a glucoside and glucuronide. Acid hydrolysis (1N HCl) also produced m-hydroxymethyl and 4-OH-tsumacide (Ohkawa et al., 1974b).

Following application to bean plants (*Phaseolus vulgaris*), metabolites observed were: N-hydroxymethyl tsumacide, m-hydroxymethyl tsumacide and 4-hydroxy tsumacide, free and conjugated (Ohkawa et al., 1974b).

BUTURON [3-(4-Chlorophenyl)-1-isobutynyl-1-methylurea]

Following administration of a single oral dose of buturon to rats, urine was collected and hydrolyzed. Thirteen metabolites were separated and identified by MS. The main excretion products were 4-chlorophenylurea; (4-chloro-2-hydroxyphenyl)urea and (4-chloro-3-hydroxyphenyl)urea. Other metabolites observed included: desmethyl buturon; 3-(4-chloro-2-hydroxyphenyl)-1-methylurea; 3-(4-chloro-3-hydroxyphenyl)-1-methylurea; 3-(4-chloro-2-hydroxyphenyl)-1-isobutynylurea; 3-(4-chloro-3-hydroxyphenyl)-1-isobutynylurea; a phenyl hydroxylated buturon; a hydroxyisobutynyl derivative; 4-chloroaniline; 4-chloroacetanilide; 4-chloro-3-hydroxy-acetanilide; and 3-(4-chlorophenyl)-1-methylurea (Grunow et al., 1978).

When applied to wheat plants, buturon was bound in part in lignin and cellulose (Haque et al., 1976a). In straw and husk extracts, metabolites identified by GC/MS were: N-(4-chlorophenyl)-N-methyl methylcarbamate; 1-formyl-3-phenylurea; 3-(4-chlorophenyl)-1-isobutenol-1-methylurea; 4-chloroformanilide; and bound 4-chloroaniline. In root and basal stem of wheat plants, N-(4-chlorophenyl)methylcarbamate and 3-(4-chlorophenyl)-1-methylurea were also observed. Two other compounds were observed but both compounds were unstable and gave 4-chlorophenylisocyanate upon purification (Haque et al., 1976b). In other studies, a 3-(chlorohydroxyphenyl)-1-methylurea, 4-chloroacetanilide and some conjugates were observed. Upon acid hydrolysis, the following products were identified by GLC/MS: 4-chloroaniline, 4-chlorophenylisocyanate, 4-chloroformanilide and N-(4-chlorophenyl)methylcarbamate (Haque et al., 1977a).

In other studies with wheat plants, buturon was metabolized to desmethyl buturon, 4-chlorophenylurea, 3-(4-chlorophenyl)-1-methylurea and the glucuronide of 4-(chlorophenyl)-1-hydroxymethylurea (Schuphan and Ebing, 1977).

Algae, exposed to buturon, metabolized buturon to 3-(4-chlorophenyl)-1-isobutenyl-1-methylurea, 3-(4-chlorophenyl)-1-(isobuten-1-ol)-1-methylurea, 3-(4-chlorophenyl)-1-methylurea and 4-chloroacetanilide (Tsorbatzoudi et al., 1976).

Incubation of buturon with the fungus Cunninghamella echinulata Thaxter produced 3-(4-chlorophenyl)-1-methylurea, 4-chlorophenylurea, desmethylbuturon and 3-(4-chlorophenyl)-1-isobutenyl-1-methylurea (Tillmanns et al., 1978).

When buturon was applied to soils, the following products were identified by GC/MS in the soil extracts: *N*-(4-chlorophenyl)-*N*-methyl methylcarbamate; *N*-(4-chlorophenyl)methylcarbamate; 3-(4-chlorophenyl)-1-isobutenyl-1-methylurea; *N*-(4-chlorophenyl)-1-methylurea; 3-(4-chlorophenyl)-1-(isobutenyl-1-ol)-1-methylurea; 3-(4-chlorophenyl)-1-methoxyisobutenyl-1-methylurea and the 1-ethoxyisobutenyl derivative; and 4-chloroaniline. In leaching water, 4-chloroformanilide, 3-(4-chlorophenyl)-*N*-methyl methylcarbamate, and 3-hydroxyphenyl-1-isobutynyl-1-methylurea were isolated and identified by GC/MS (Haque et al., 1977b).

CHLOROTOLURON [3-(3-Chloro-4-methylphenyl)-1,1-dimethylurea]

When ^{14}C-chlorotoluron was incubated with human embryonic lung (HEL) cells, over 95% of the label was recovered intact. Metabolites were identified by chromatography as 3-(3-chloro-4-methylphenyl)-1-formyl-1-methylurea, 3-(3-chloro-4-methylphenyl)-1-formylurea, 3-(3-chloro-4-methylphenyl)-1-methylurea and (3-chloro-4-methylphenyl) urea (Lin et al., 1976).

Most of the ^{14}C-chlorotoluron administered as a single oral dose to rats was excreted in urine. Of 11 urinary metabolites isolated, nine were identified by spectroscopic procedures: 3-(3-chloro-4-methylthiomethylphenyl)-1,1-dimethylurea; 3-(3-chloro-4-methylthiomethylphenyl)-1-methylurea; (3-chloro-4-methylthiomethylphenyl)urea; (3-chloro-4-methylphenyl)urea; 3-(3-chloro-4-hydroxymethylphenyl)-1,1-dimethylurea, free and conjugated; 3-(3-chloro-4-hydroxymethylphenyl)-1-methylurea; (3-chloro-4-hydroxymethylphenyl)urea; 3-(3-chloro-4-carboxyphenyl)-1,1-dimethylurea; 3-(3-chloro-4-carboxyphenyl)-1-methylurea; and (3-chloro-4-carboxyphenyl)urea (Muecke et al., 1976).

In Japanese quail, chlorotoluron metabolism occurred only in post-mitochondrial fractions of liver. The major metabolites observed were desmethyl chlorotoluron and 3-(3-chloro-4-hydroxymethylphenyl)-1-methylurea (Hinderer, 1975; Hinderer and Menzer, 1976b).

In soil, chlorotoluron had a half-life of 4-6 weeks. Only the desmethyl derivative was observed. When 3-chloro-4-methylaniline, a potential metabolite, was applied to soil, after 72 h no aniline was found. However, two new products were formed by N-N coupling: the azo 3,3'-dichloro-4,4'-dimethylazobenzene and the quinone anil *N*-(3-chloro-4-methylphenyl)-3-chloro-4-methyl-2-oxo-anil (Smith and Briggs, 1978).

CLEARCIDE (KUE 2079A) [3-(3-Chloro-4-chlorodifluoromethylthiophenyl)-1,1-dimethylurea]

Rice plants were planted in paddy soils under flooded conditions and treated with clearcide. The major metabolites, identified by MS, were desmethyl clearcide and clearcide sulfoxide and sulfone. Desmethyl clearcide sulfoxide and sulfone, 3-chloro-4-chlorodifluoromethylthioaniline, and di-desmethyl clearcide were also observed (Takase et al., 1978).

UREAS

DIFLUBENZURON (Dimilin, TH-6040, N-(4-Chlorophenylcarbamoyl)-2,6-difluorobenzamide) [1-(4-Chlorophenyl)-3-(2,6-difluorobenzoyl)urea]

After oral treatment of a cow and a castrated sheep with labeled diflubenzuron (I), urine was collecte and analyzed. TLC indicated the presence of eight labeled materials. The major compounds in the sheep urine were identified as 2,6-difluorobenzoic acid (III) and the hippurate analog (IV). In the cow's urine, 2,6-difluoro-3-hydroxydiflubenzuron (V) was the major metabolite. Metabolites VI and VII were also seen in urine of both cow and sheep but the 4-chlorophenylurea (VIII) was seen only in the urine of the cow. Feces of both animals contained compounds V, VI and VII. In the bile, compounds V, VI and VII also appeared in addition to unidentified conjugates. Incubation of bile water-soluble metabolites with β-glucuronidase-aryl sulfatase converted about half the labeled material into organic extractable materials. Although TLC indicated eight radioactive compounds, none were identified. Analysis of milk indicated the presence of unchanged diflubenzuron, 2,6-difluorobenzamide (II), compound V, 2,6-difluorohippuric acid (IV), and an unidentified compound. Digestive fluids of sheep and cattle did not significantly degrade diflubenzuron. When metabolite V was orally administered to rats, almost all of the material was excreted within 3 days. Analyses indicated the presence of five additional compounds. None were identified (Ivie, 1978).

Diflubenzuron was applied topically to adult stable flies and houseflies. Stable flies metabolized only about 2% of the diflubenzuron while in houseflies this amounted to about 10%. Metabolism in the two flies differed qualitatively as well. Extracts of stable flies contained 2,6-difluorobenzamide and 4-chloroacetanilide (IX). Extracts of houseflies did not contain these. Two unidentified metabolites were seen in houseflies but not stable flies. In addition to these, 4-chlorophenylurea (VIII) and one unknown compound were observed in both flies (Ivie and Wright, 1978).

Flies (Musca domestica) were treated with diflubenzuron ^{14}C-labeled in both rings. About 20% of the label appeared in conjugated form. When the excreta was subjected to acid hydrolysis, two compounds were observed. TLC, UV and MS were used to identify one compound as the 4-chloro-2-hydroxyphenyl derivative (Chang, 1978).

Under conditions approximating normal use, diflubenzuron was persistent on cotton plants and resistant to photodecomposition (Bull and Ivie, 1978).

When applied to diflubenzuron, algae degraded 80% in one hour primarily to p-chlorophenylurea and p-chloroaniline (Booth and Ferrell, 1977).

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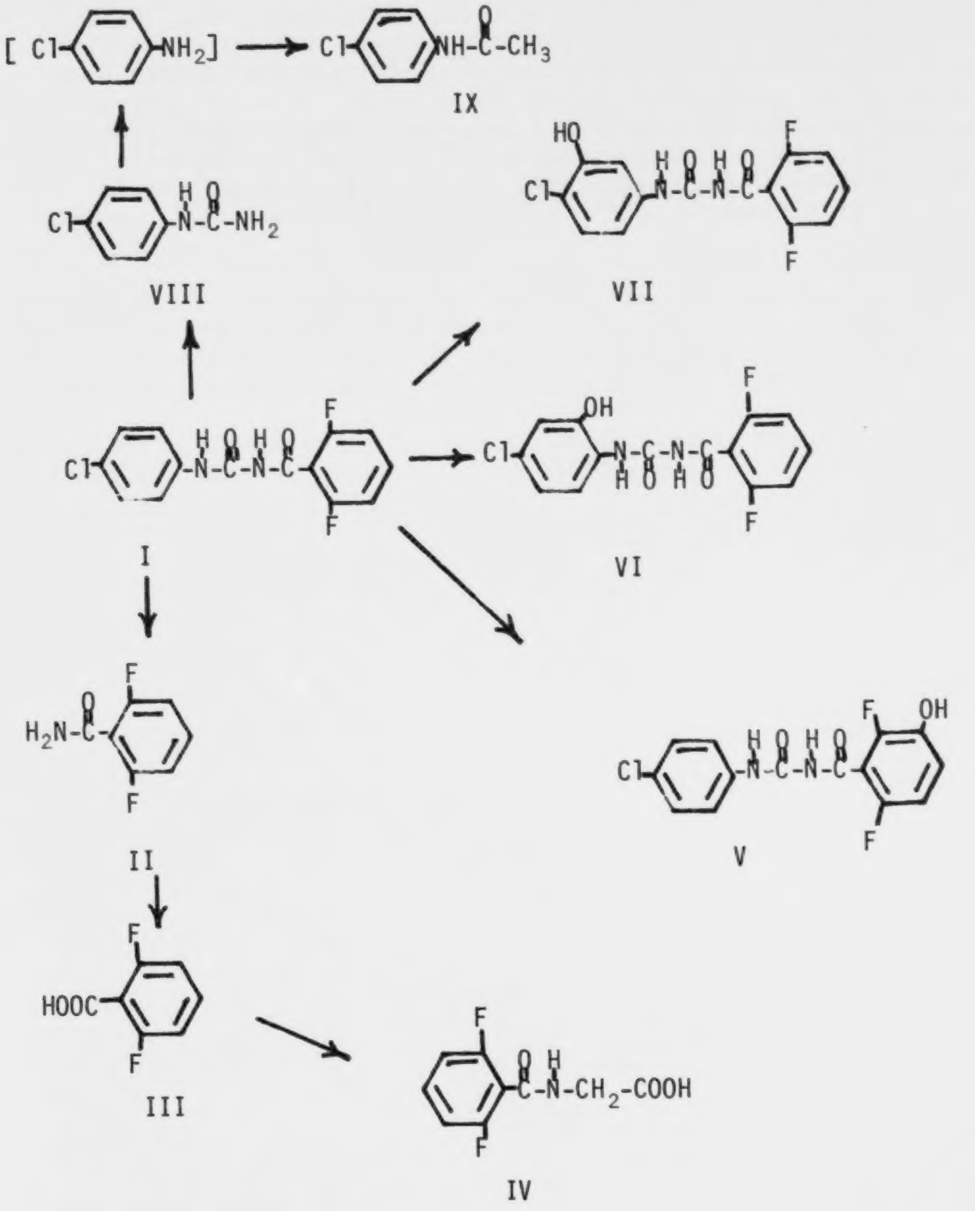
Diflubenzuron was stable in water and recoveries were 97% or better. Hydrolysis was very slow and produced p-chlorophenylurea. As pH and temperature increased, stability decreased (Schaefer and Dupras, Jr., 1976).



I
II
III
IV
V
VI
VII
VIII
IX

UREAS

DIMURON [1-(α,α-Dimethylbenzyl)-3-(p-tolyl)urea]

About 70% of an orally administered dose of carbonyl-^{14}C-dimuron was absorbed by male Wistar rats; and, within 48 h, the entire dose was eliminated via feces (66%) and urine (34%). TLC of the urine indicated the presence of several metabolites. A major metabolite was identified by chromatography as 1-(α,α-dimethylbenzyl)-3-(p-carboxyphenyl)urea. p-Toluidine and $^{14}CO_2$ were also observed. An unidentified ^{14}C-labeled β-glucuronide was detected in bile (Kato et al., 1978).

DIURON [3-(3,4-Dichlorophenyl)-1,1-dimethylurea]

In Hilo soil, the $t_{1/2}$ for diuron was 130 days and in Molokai, 160 days. The major degradation product of diuron was monomethyl diuron. Conjugated residues were also formed (Elder et al., 1978).

Sugarcane (*Saccharum officinarum* L.) converted diuron to desmethyl diuron, 3,4-dichlorophenylurea and glucose conjugates of *N*-hydroxymethyl diuron and desmethyl diuron. The latter was the predominant conjugate. Other metabolites, not identified, were also present (Liu et al., 1978).

Degradation of diuron in soil followed first-order kinetics. Residue levels of diuron in soil were phytotoxic to oats for 3 years following the last diuron application. Levels of 3,4-dichloroaniline were present but low in all soil samples (Khan et al., 1976b).

Incubation of diuron with the fungus *Cunninghamella echinulata* Thaxter produced 3-(3,4-dichlorophenyl)-1-methylurea and 3,4-dichlorophenylurea (Tillmanns et al., 1978).

FLUOMETURON [1,1-Dimethyl-3-(3-trifluoromethylphenyl)urea]

When ^{14}C-fluometuron was incubated with human embryonic lung (HEL) cells, more than 95% was recovered unchanged. Three metabolites were identified: 1-formyl-1-methyl-3-(3-trifluoromethylphenyl)urea; 1-methyl-3-(3-trifluoromethylphenyl)urea; and 3-trifluoromethylphenylurea (Lin et al., 1976).

After 35 days incubation, Rhizoctonia solani degraded 88% of ^{14}C-fluometuron to polar and water-soluble metabolites. No $^{14}CO_2$ was observed. Two major metabolites were identified by TLC and UV as 1-methyl-3-(3-trifluoromethylphenyl)urea and 3-trifluoromethylphenylurea. Five other metabolites were not identified (Rickard and Camper, 1978).

UREAS

LINURON [*N*-(3,4-Dichlorophenyl)-*N*'-methoxy-*N*'-methylurea]

Linuron was hydrolyzed by *Bacillus sphaericus* ATCC 12123 to form 3,4-dichloroaniline, CO_2, and *N,O*-dimethylhydroxylamine (Engelhardt and Wallnofer, 1976b).

Incubation of linuron with the fungus *Cunninghamella echinulata* Thaxter produced 3-(3,4-dichlorophenyl)-1-methylurea, 3,4-dichlorophenylurea, desmethyl linuron, and 3-(3,4-dichlorophenyl)-1-methoxy-1-hydroxymethylurea (Tillmanns et al., 1978).

METHABENZTHIAZURON (MBT) [1-(2-Benzothiazolyl)-1,3-dimethylurea]

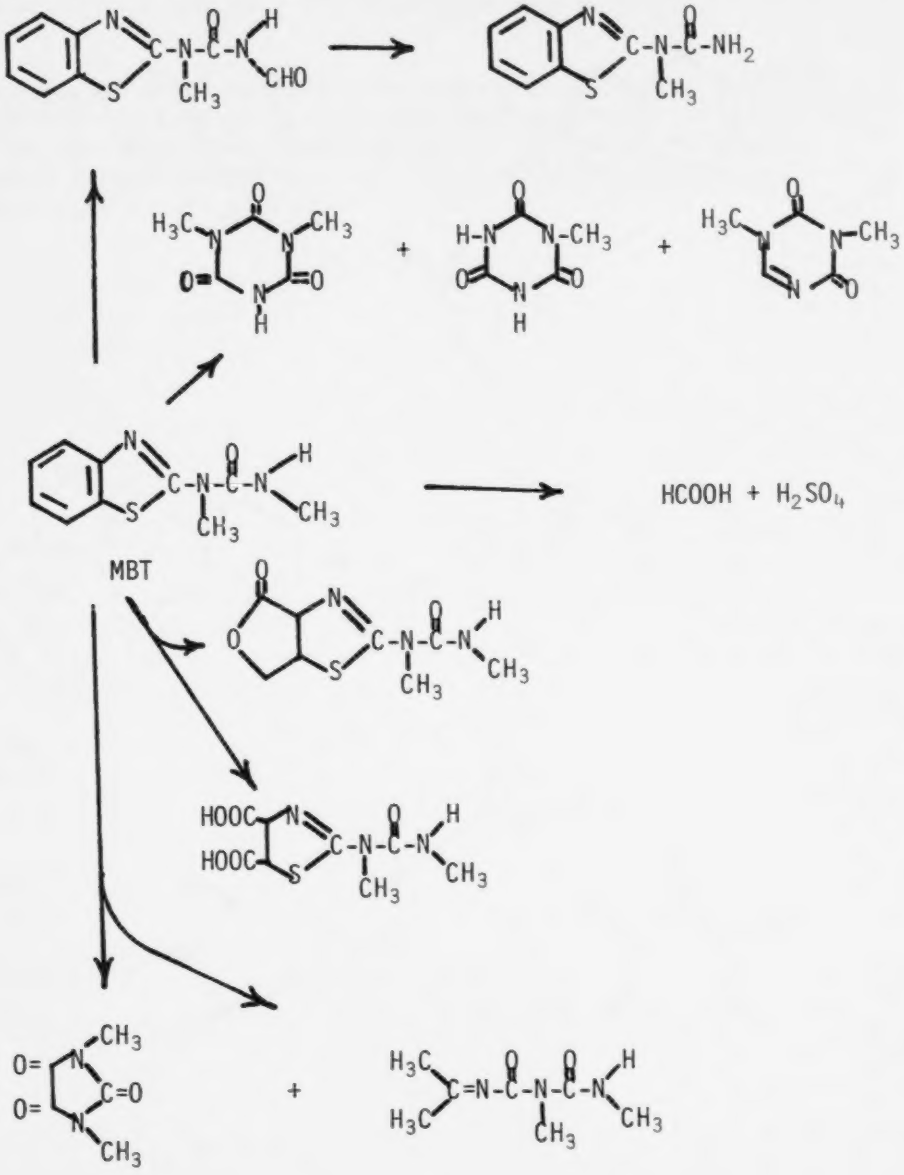
A fungus of Ascomycetes class metabolized MBT. Chromatography and spectroscopy were used to identify six metabolites: 3-desmethyl MBT; 1-desmethyl MBT; 3-hydroxymethyl MBT; *N*-(2-benzothiazolyl)-*N*-methylamine; 1,3-dimethyl-1-(6-hydroxybenzothiazol-2-yl)urea; and a ring-hydroxylated MBT derivative not further characterized (Goettfert et al., 1978).

Incubation of MBT with the fungus *Cunninghamella echinulata* produced the following compounds which were identified by chromatography and spectroscopy: 1-desmethyl MBT; and 5(6)-ring hydroxylated MBT (Wallnofer et al., 1976).

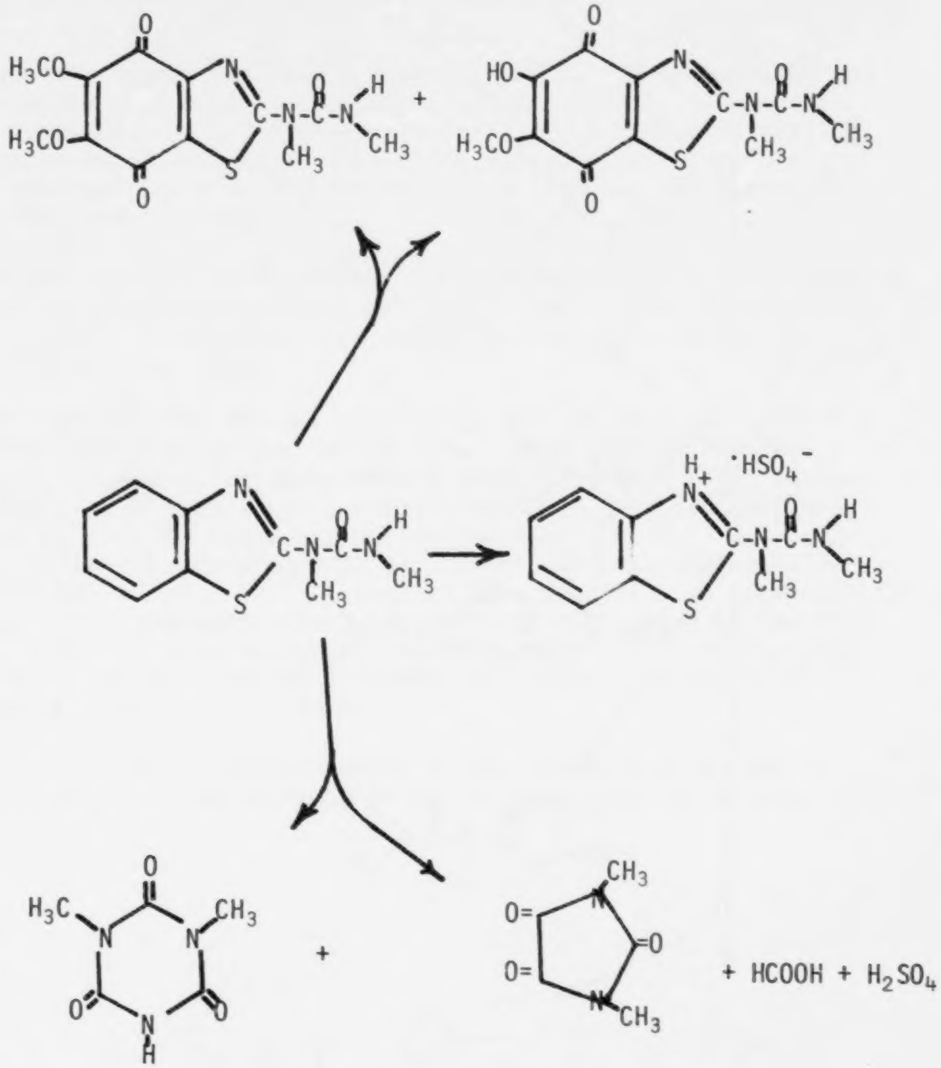
Benzothiazolyl-2-^{14}C MBT was applied to soil in pots and maize seedlings were then placed in the pots. When initially wetted, there was a burst of activity with a relatively high $^{14}CO_2$ release. The rate then dropped after 3 weeks to below 0.01% per day (Cheng et al., 1974). The major metabolite isolated from soil was identified by MS and chromatography as 1-methyl-1-(2-benzthiazolyl)urea (Mittelstaedt et al., 1977). In ancillary studies, the heterocyclic portion of MBT degraded slowly but this was influenced by the side chain. When the side chain was shortened from a substituted urea to an amino group, then the benzothiazolyl moiety became more degradable (Cheng et al., 1978).

Photolysis of MBT in acetone/water in the presence of O_2 and in methanol/water in the presence of O_2 is shown (Sakriss et al., 1976).

Irradiation in acetone/water + O_2


MBT
HCOOH + H2SO4

Irradiation in methanol/water + O_2



·HSO₄⁻
+ HCOOH + H₂SO₄

UREAS

METOBROMURON [3-(4-Bromophenyl)-1-methoxy-1-methylurea]

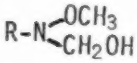
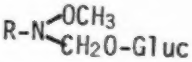
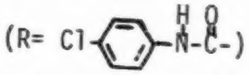
^{14}C-Metobromuron was incubated with human embryonic lung (HEL) cells. More than 95% of the label was recovered as unchanged metobromuron. Of four metabolites, three were identified: 3-(4-bromophenyl)-1-methylurea; 4-bromophenylurea; and 3-(4-bromophenyl)-1-hydroxy-1-methylurea (Lin et al., 1976).

MONOLINURON [3-(4-Chlorophenyl)-1-methoxy-1-methylurea]

Six hours after administration of monolinuron to pigs, collected urine was analyzed. The biotransformation products found included 3-(4-chlorophenyl)-1-hydroxymethyl-1-methoxyurea, desmethyl monolinuron, 4-chlorophenylurea, (4-chloro-2-hydroxyphenyl)urea, (4-chloro-3-hydroxyphenyl)urea, and glucuronides and/or sulfates of the latter two hydroxy compounds (Hilbig et al., 1977).

When applied to spinach plants, monolinuron was metabolized to 3-(4-chlorophenyl)-1-hydroxymethyl-1-methoxyurea and its glucoside, desmethyl monolinuron, 4-chlorophenylurea, and 3-(4-chlorophenyl)-1-(glucosyl methyl)urea (Schuphan and Ebing, 1975).

Spinach seeds were planted in sandy loam soil which was treated with monolinuron. After harvesting spinach, cress (Lapidium sativum) and potatoes were in turn planted. Plant matter and soil were analyzed. Results are tabulated.

Metabolites	Found in
$R-NH-OCH_3$	Spinach, cress, potatoes, soil
$R-NH-CH_3$	Spinach, cress, potatoes, soil
$R-NH_2$	Spinach, cress, potatoes, soil
$R-NH-CH_2OH$	Spinach, cress, potatoes
 $R-N\begin{smallmatrix}OCH_3\\CH_2OH\end{smallmatrix}$	Spinach, cress, potatoes, soil
$R-NH-CH_2O-Gluc$	Spinach, cress, potatoes, soil
 $R-N\begin{smallmatrix}OCH_3\\CH_2O-Gluc\end{smallmatrix}$	Spinach, cress, potatoes, soil
	(Schuphan and Ebing, 1978)

The β-glucoside of hydroxymethylmonolinuron was applied to spinach plants. About 34% of the compound was metabolized by the plants within 7 days. In soil, 23% was mineralized to CO_2 and 13% was in the form of metabolites identified as: 3-(4-chlorophenyl)-1-hydroxymethyl-1-methoxyurea; 4-chlorophenylurea; 3-(4-chlorophenyl)-1-methoxyurea (Haque et al., 1978a and b).

Incubation of monolinuron with the fungus *Cunninghamella echinulata* Thaxter produced 3-(4-chlorophenyl)-1-methylurea, 4-chlorophenylurea, 3-(4-chlorophenyl)-1-hydroxymethyl-1-methoxyurea and 3-(4-chlorophenyl)-1-methoxyurea (Tillmanns et al., 1978).

The mineralization rate of the ureido-group was dependent on the soil and $^{14}CO_2$ release was more rapid from the methyl and ureido groups than from the phenyl ring (Suss and Eben, 1978).

MONURON [3-(4-Chlorophenyl)-1,1-dimethylurea]

Sweet orange seedlings took up monuron and metabolized it to 3-(4-chlorophenyl)-1-methylurea and 4-chlorophenylurea. Water soluble metabolites developed over the period of one day to 10 weeks of exposure. TLC, IR, MS and enzymatic hydrolysis indicated that monuron was conjugated with fructose or O-methylglucuronic acid after loss of halogen and hydroxylation (Dawson, 1977).

When incubated with the fungus Cunninghamella echinulata Thaxter, monuron yielded 3-(4-chlorophenyl)-1-methylurea and 4-chlorophenylurea (Tillmanns et al., 1978).

Saturated aqueous solutions of monuron were treated with ferrous sulfate + hydrogen peroxide (Fenton's reagent). Products were characterized spectroscopically: 3-(4-hydroxyphenyl)-1,1-dimethylurea; 4-chlorophenylurea; 3-(4-chlorophenyl)-1-methylurea; 4-chloro-2-hydroxyphenylurea; 3-(4-chloro-2-hydroxyphenyl)-1-methylurea; 3-(4-chloro-2-hydroxyphenyl)-1,1-dimethylurea; 4-chloro-2-benzoxazolinone; 4-chloro-2,4'-dihydroxycarbanilide; and 4-chloro-4'-hydroxycarbanilide (Tanaka and Wien, 1977).

UV irradiation of saturated aqueous solutions of monuron produced the following identified compounds: 3-(4-chlorophenyl)-1-formyl-1-methylurea; 3-(4-chlorophenyl)-1-methylurea; 3-(4-hydroxyphenyl)-1-formyl-1-methylurea; 4,4'-dichlorocarbanilide; 3-(4-hydroxyphenyl)-1,1-dimethylurea; 3-(4-chloro-2-hydroxyphenyl)-1,1-dimethylurea; the dimer, 3-[4-(N-(N',N'-dimethylaminocarbonyl)-4'-chloroanilino)phenyl]-1,1-dimethylurea; the p-hydroxy dimer; a dihydroxy dimer; the monodealkylated dimer; and tentatively a trimeric product (Tanaka et al., 1976 and 1977a).

TEBUTHIURON (EL-103) [1,3-Dimethyl-3-(5-(1,1-dimethylethyl)-1,3,4-
thiadiazol-2-yl)urea]

^{14}C-Tebuthiuron was administered as a single dose to mice, rats, rabbits, dogs and ducks. ^{14}C Excretion was almost complete within 72 h. Mice excreted 30% of the label in feces. The other mammals excreted almost all radioactivity in urine. Collected urine was acid-hydrolyzed at pH 6.5 with ethyl acetate. Four compounds were identified as: 1-desmethyl tebuthiuron; 3-desmethyl tebuthiuron; 1,3-di-desmethyl tebuthiuron; 1-hydroxymethyl tebuthiuron. Also identified, as a β-glucuronide, was 1-[5-(1,1-dimethyl-2-hydroxyethyl)-1,3,4-thiadiazol-2-yl]-1-methylurea; free and conjugated in rat, rabbit and dog urine, 1-[5-(1,1-dimethyl-2-hydroxyethyl)-1,3,4-thiadiazol-2-yl]-3-methylurea; and 1,3-di-desmethyl tebuthiuron (Morton and Hoffman, 1976).

When applied to rangeland grasses under laboratory conditions, tebuthiuron underwent *N*-demethylation and hydroxylation of the dimethylethyl side chain (Magnussen and Rainey, 1977).

In sugarcane, tebuthiuron was converted to 1-(5-*tert*-butyl-1,3,4-thiadiazol-2-yl)-1-methylurea and 1-(5-*tert*-butyl-1,3,4-thiadiazol-2-yl)-3-(hydroxymethyl)-1-methylurea. In soil, demethylated metabolites and volatile metabolites were formed (Eaton et al., 1976).

THIDIAZURON [1-Phenyl-3-(1,2,3-thiadiazol-5-yl)urea]

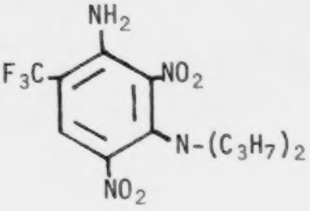
When rats were administered single doses of radiolabeled thidiazuron, more than 90% of the label was excreted within 96 h in urine and feces. In continuous feeding studies, about 90% of the daily dose was excreted in urine (35%) and feces (55%). Lactating goats and laying hens excreted more than 70%. A major metabolite was identified by MS as 1-(4-hydroxyphenyl)-3-(1,2,3-thiadiazol-5-yl)urea, free and conjugated as glucuronide and sulfate, in rat and goat urine, feces, and milk, and in hen excreta, eggs and tissues. Phenylurea was also detected. In the dietary studies, rat and goat urine contained phenylurea. The photoproduct, 1-phenyl-3-(1,2,5-thiadiazol-3-yl)urea, was also eliminated by rats in greater than 70% amount in 96 h (Benezet et al., 1978; Knowles et al., 1978).

In other studies, thidiazuron was administered as a single oral dose to rats. Within 96 h, more than 90% of the dose was eliminated via urine and feces. Phenylurea and 4-hydroxyphenyl-thidiazuron, free and conjugated as a glucoside and/or sulfate, were identified by chromatography and MS (Crecelius and Knowles, 1978).

Thidiazuron was irradiated in aqueous solution at λ>290 nm. Elemental analysis, MW determination, NMR, IR and UV showed that after 40 minutes the main photoproduct was an isomer of thidiazuron. X-ray analysis indicated that the product was probably 1-phenyl-3-(1,2,5-thiadiazol-3-yl)urea (Buhmann et al., 1978).

USB 3153 [N^3,N^3-Di-*n*-propyl 2,4-dinitro-6-trifluoromethyl-*m*-phenylenediamine]

In soil, under aerobic conditions, the monodealkylated USB 3153 (II) and the benzimidazole (III) were formed. Under anaerobic conditions, compounds IV and V were the major metabolites (Griffin, 1976). Soil bound residues were observed but not identified (Griffin, 1977).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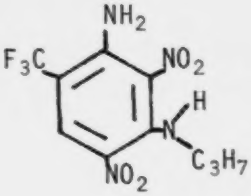
F3C
NO2
N-(C3H7)2
NO2

I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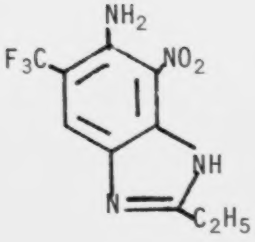
NO2
H
N
C3H7
NO2

II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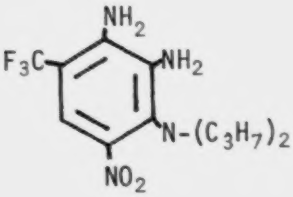
NH
N
C2H5

III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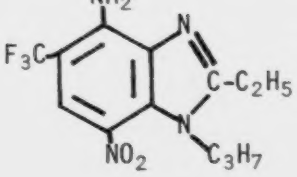
F3C
NH2
N-(C3H7)2
NO2

IV


NH2
F3C
N
C-C2H5
N
C3H7
NO2

V

VACOR (RH 787) [1-(3-Pyridylmethyl)-3-(4-nitrophenyl)urea]

In a case of human poisoning with vacor, analysis of the liver revealed the presence of *p*-nitroaniline. This was confirmed by GC on two columns (Osteryoung et al., 1976).

VEL 5026 [2-(5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl)-4-hydroxy-1-methyl-2-imidazolidinone]

In soil Vel 5026 was converted to eight metabolites. Five were identified as: 3-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-4,5-dihydroxy-2-imidazolidinone; 3-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-1-methylurea; 3-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]urea; 5-amino-2-(1,1-dimethylethyl)-1,3,4-thiadiazole; and 3-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-1-methyl dihydroimidazole-2-one (Carringer and Rieck, 1976).

Vel 5026 was leached through columns of soil. TLC indicated the presence of the dihydroxy, desmethyl dihydroxy, methylurea, urea and amine metabolites (Peeper and Weber, 1976).

WARFARIN [3-(α-Acetonylbenzyl)-4-hydroxycoumarin]

When racemic warfarin was administered to normal humans, seven compounds were observed in urine. With TLC, UV and MS, four compounds were identified: two diastereoisomeric alcohols resulting from reduction of the acetonyl side chain; 6-hydroxywarfarin; and 7-hydroxywarfarin (Lewis and Trager, 1970). Of these compounds, the presence of 7-hydroxywarfarin alone could not be confirmed in plasma (Hewick and McEwen, 1973). In other studies with racemic warfarin, the warfarin alcohols plus 6- and 7-hydroxywarfarin and a compound identified by MS as benzylic hydroxywarfarin were found in urine of a human subject (Pohl et al., 1975).

The 6-, 7-, 8-, and 4'-hydroxywarfarins formed by liver microsomal cytochrome P-450 of mammals and birds varied quantitatively. Mammals produced equal amounts of the four compounds whereas birds produced 6- > 7- > 8-hydroxywarfarin (Townsend and Tarrant, 1977).

Guinea pigs, injected i.p. with 4-[^{14}C]-warfarin sodium, metabolized this compound to six urinary compounds identified by isotope dilution: 4'-hydroxywarfarin; 6-hydroxywarfarin; 7-hydroxywarfarin; 8-hydroxywarfarin; salicylic acid; and 2,3-dihydro-2-methyl-4-phenyl-5-oxo-4H-pyrano[3,2-C]-2H-benzopyran. These compounds were also observed in feces (Deckert, 1973).

In male Sprague-Dawley rats, the biological half-life of warfarin varied from 5-28 h (Yacobi et al., 1974). Rat liver microsomes plus an NADPH generating system converted warfarin to 6-, 7-, 8-, and 4'-hydroxywarfarin plus a compound identified by MS as benzylic hydroxywarfarin (Pohl et al., 1975). In other studies, hepatic microsomes produced in addition to the four foregoing hydroxywarfarins and the 4H-pyrano-2H-benzopyran metabolite, another metabolite of warfarin identified by NMR and comparison with the synthesized compound as dehydrowarfarin: 4-hydroxy-3-(3-oxo-1-phenyl-1-butenyl)-2H-1-benzopyran-2-one (Fasco et al., 1978). Another metabolite of a rat hepatic microsomal-NADPH-dependent system has been identified as 6-(1-hydroxy-2-oxo-3-phenylhexylidene)-2,4-cyclohexadien-1-one (Thonnart et al., 1977).

Rats converted the R enantiomer stereoselectively to 7-hydroxywarfarin but the S enantiomer to 4'-hydroxywarfarin. Both enantiomers were converted about equally to 6-, 8-, and benzylic hydroxywarfarin. Side chain ketone reduction to the diastereomeric warfarin alcohols was stereoselective for the S isomer. Urine contained polar labile conjugates of R and S warfarin. Conjugation appeared to be selectively at the 4-hydroxyl position and involved glucuronide and/or sulfate conjugates (Pohl et al., 1976).

XMC [N-Methyl-3,5-xylyl carbamate]

XMC was applied to the green rice leafhopper (Nephotettix cincticeps Uhler) and the smaller brown planthopper (Laodelphax striatellus Fallen). Penetration into the insect was rapid and about 10-12 metabolites were formed. Only the N-hydroxymethyl metabolite was identified (Kazano et al., 1978).

Abe, L.O.
1975. Uptake and metabolism of 3,4-dichloroaniline in rice (*Oryza sativa* var. Starbonnet) root-derived callus suspension culture. Dissert. Abstr., 35(10):4744-4745.

Abou-Donia, M.B., and D.B. Menzel.
1976. DDT: The degradation of ring-labeled ^{14}C-DDT to $^{14}CO_2$ in the rat. Experientia, 32:500-501.

Ackermann, H., H. Faust, Y.S. Kagan, and V.H. Voronina.
1978. Metabolic and toxic behaviours of phthalimide derivatives in albino rats. II. Placental passage of chloromethyl phthalimide, oxymethyl phthalimide, and phthalimide--Their fetal metabolism. Arch. Toxicol., 40:255-261.

Ackermann, H., und B. Lexow.
1975. *In-vitro*-Untersuchungen zum Abbau von Chlormequat (*Chlorcholinchlorid*) im Pansen. Archiv fur Experiment. Veterinar., 29(3):331-334.

Ackermann, H., H. Seidler, Y.S. Kagan, and V.M. Voronina.
1976. Metabolic and toxic behaviour of phthalimide derivatives. I. Fate of imidan in the fetus. Arch. Toxicol., 36:127-137.

Addison, J.B., P.J. Silk, and I. Unger.
1975. The photochemistry of carbamates V. The photodecomposition of sevin (1-naphthyl-*N*-methyl carbamate) and of phenmec (phenyl-*N*-methyl carbamate). *I*ntern. J. Environ. Anal. Chem., 4:135-140.

Addison, R.F.
1978. DDT degradation in trout: Comparison with mammalian routes. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-522.

Addison, R.F., and D.E. Willis.
1978. The metabolism by rainbow trout (*Salmo gairdnerii*) of *p,p*'[^{14}C]DDT and some of its possible degradation products labeled with ^{14}C. Toxicol. Appl. Pharmacol., 43:303-315.

Addison, R.F., and M.E. Zinck.
1974. The metabolism of some DDT-type compounds by brook trout (*Salvelinus fontinalis*). Environ. Qual. Safety, 3(Suppl.):500-506.

Addison, R.F., and M.E. Zinck.
1977. Rate of conversion of ^{14}C-*p,p*'-DDT to *p,p*'-DDE by Brook Trout (*Salvelinus fontinalis*): Absence of effect of pretreatment of fish with compounds related to *p,p*'-DDT. J. Fish. Res. Bd. Canada, 34(1): 119-122.

Addison, R.F., M.E. Zinck, and J.R. Leahy.
1976. Metabolism of single and combined doses of ^{14}C-aldrin and ^{3}H-*p,p*'-DDT by Atlantic salmon (*Salmo salar*) Fry. J. Fish. Res. Bd. Canada, 33(9):2073-2076.

Adir, J., Y.H. Caplan, and B.C. Thompson.
1978. Kepone serum half-life in humans. Life Sci., 22(8):699-702.

Adir, J., R.P. Miller, and K.S. Rotenberg.
1976. Disposition of nicotine in the rat after intravenous administration. Res. Comm. Chem. Path. Pharm., 13(2):173-183.

Adler, I.L., B.M. Jones, and J.P. Wargo, Jr.
1977. Fate of 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene (oxyfluorofen) in rats. J. Agric. Food Chem., 25(6): 1339-1341.

Adler, I., L. Roser, and J.P. Wargo.
1975. Rhom and Haas Co., unpublished data, 1971, from Wargo, J.P. et al., J. Agric. Food Chem., 23(6):1095-1097.

Agarwal, H.C., D.V. Yadav, and M.K.K. Pillai.
1978. Metabolism of ^{14}C-DDT in *Pheretima posthuma* and effect of pretreatment with DDT, lindane and dieldrin. Bull. Environ. Contam. Toxicol., 19:295-299.

Aharonson, N., and U. Kafkafi.
1975a. Adsorption of benzimidazole fungicides on montmorillonite and kaolinite clay surfaces. J. Agric. Food Chem., 23(3):434-437.

Aharonson, N., and U. Kafkafi.
1975b. Adsorption, mobility, and persistence of thiabendazole and methyl 2-benzimidazolecarbamate in soils. J. Agric. Food Chem., 23(4):720-724.

Ahlborg, U.G.
1978. Dechlorination of pentachlorophenol *in vivo* and *in vitro*. *In* Pentachlorophenol, 115-130. Ed. K. Ranga Rao, Published by Plenum Publ. Corp.

Ahlborg, U.G., and K. Larsson.
1978. Metabolism of tetrachlorophenols in the rat. Arch. Toxicol., 40:63-74.

Ahlborg, U.G., K. Larsson, and T. Thunberg.
1978. Metabolism of pentachlorophenol *in vivo* and *in vitro*. Arch. Toxicol., 40:45-53.

Ahling, B., and A. Lindskog.
1978. Thermal destruction of PCB and hexachlorobenzene. Sci. Total Environ., 10:51-59.

Ahling, B., A. Lindskog, B. Jansson, and G. Sundstrom.
1977. Formation of polychlorinated dibenzo-*p*-dioxins and dibenzofurans during combustion of a 2,4,5-T formulation. Chemosphere, 6(8):461-468.

Ajami, A.M., and L.M. Riddiford.
1973. Comparative metabolism of the Cecropia juvenile hormone. J. Insect Physiol., 19:635-645.

Akagi, H., Y. Fujita, and E. Takabatake.
1977. Methylmercury: Photochemical transformation of mercuric sulfide into methylmercury in aqueous solutions. Photochem. Photobiol., 26:363-370.

Akermark, B., P. Baeckstrom, U.E. Westlin, R. Gothe, and C.A. Wachtmeister.
1976. Photochemical dechlorination of 1,2,4-trichlorobenzene. Acta Chem. Scand., B 30:49-52.

Akhtar, M.H.
1977. Degradation of tetrachlorvinphos and its major metabolite 2,4,5-trichlorophenacyl chloride in aqueous media. J. Agric. Food Chem., 25(4):848-851.

Akhtar, M.H.
1978. *In vitro* metabolism of desmethyl tetrachlorvinphos by soluble fraction (105000g) from chicken liver homogenates. J. Agric. Food Chem., 26(4):932-935.

Akhtar, M.H., and T.S. Foster.
1977. Metabolism of tetrachlorvinphos by the soluble fraction (105,000g) from chicken liver homogenates. J. Agric. Food Chem., 25(5):1017-1022.

Akins, M.B., and R.J. Lewis.
1976. Chemical distribution and gaseous evolution of arsenic-74 added to soils as DSMA-^{74}As. Soil Sci. Soc. Amer. J., 40(5): 655-658.

Akov, S., and A.B. Borkovec.
1968. Metabolism of the chemosterilant hempa by carbamate-resistant house flies. Life Sci., 7(Part II):1215-1218.

Akov, S., J.E. Oliver, and A.B. Borkovec.
1968. *N*-Demethylation of the chemosterilant hempa by house fly microsomes. Life Sci., 7(Part II):1207-1213.

Akram, M., S. Ahmad, and A.J. Forgash.
1978. Metabolism of phosphorothioic acid, *O*,*O*-dimethyl-*O*-(6-ethoxy-2-ethyl-4-pyrimidinyl)ester (Etrimfos), in bean and corn plants. J. Agric. Food Chem., 26(4):925-931.

Alarcon, R.A., and J. Meienhofer.
1971. Formation of the cytotoxic aldehyde acrolein during *in vitro* degradation of cyclophosphamide. Nature New Biol., 233: 250-252.

Ali, S.
1978. Degradation and environmental fate of endosulfan isomers and endosulfan sulfate in mouse, insect and laboratory model ecosystem. Dissert. Abstr., 39B(5):2117.

Allcock, E.R., D.R. Woods, and D.E.A. Rivett.
1978. Bacterial degradation products of the ixodicide amitraz. J. Appl. Bacteriol., 44:383-386.

Allen, J.L., J.B. Hunn, and V.K. Dawson.
1978. Biotransformation of selected chemicals by fish. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 72.

Alley, E.G., and B.R. Layton.
1976. Aqueous photochemistry of mirex. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 95.

Alumot, E., and E. Mandel.
1976. Intestinal absorption and distribution of decachlorbiphenyl in rats and chicks. Bull. Environ. Contam. Toxicol., 16(6):746-749.

Alvarez, M., R.W. Creekmore, and R.T. Rosen.
1973. Structure of ethylenethiuram monosulfide. Tetrahedron Lett., 12:939-942.

Ambrosi, D., and C.S. Helling.
1977. Leaching of oxadiazon and phosalone in soils. J. Agric. Food Chem., 35(1):215-217.

Ambrosi, D., A.R. Isensee, and J.A. Macchia.
1978. Distribution of oxadiazon and phosalone in an aquatic model ecosystem. J. Agric. Food Chem., 26(1):50-53.

Ambrosi, D., P.C. Kearney, and J.A. Macchia.
1976a. Persistence and metabolism of phosalone in soil. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 106.

Ambrosi, D., P.C. Kearney, and J.A. Macchia.
1976b. Persistence and metabolism of oxadiazon in soil. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 107.

Ambrosi, D., P.C. Kearney, and J.A. Macchia.
1977a. Persistence and metabolism of phosalone in soil. J. Agric. Food Chem., 25(2):342-347.

Ambrosi, D., P.C. Kearney, and J.A. Macchia.
1977b. Persistence and metabolism of oxadiazon in soils. J. Agric. Food Chem., 25(4):868-872.

Anagnostopoulos, E., I. Scheunert, W. Klein, and F. Korte.
1978. Contributions to ecological chemistry CXLIII. Conversion of *p*-chloroaniline-^{14}C in green algae and water. Chemosphere, 7(4):351-357.

Anderson, J.P.E.
1975. Einfluss von temperatur und Feuchte auf Verdampfung, Abbau und Festlegung von Diallat im Boden. Pflanzenkrank. u. Pflanzenschutz, 7:141-146.

Anderson, J.P.E., and K.H. Domsch.
1976. Microbial degradation of the thiolcarbamate herbicide, diallate, in soils and by pure cultures of soil microorganisms. Arch. Environ. Contam. Toxicol., 4:1-7.

Andersson, K., A. Norstrom, C. Rappe, B. Rasmuson, and H. Swahlin.
1974. Photochemical degradation of PCB, PBB and other flame retardants. Environ. Qual. Safety, 3(Suppl.):798-802.

Ando, M., Y. Iwasaki, and M. Nakagawa.
1975. Metabolism of isoxathion, *O,O*-diethyl *O*-(5-phenyl-3-isoxazolyl) phosphorothionate in plants. Agr. Biol. Chem., 39(11):2137-2143.

Ando, M., T. Nakamura, and M. Nakagawa.
1974. Metabolism of hymexazol, 3-hydroxy-5-methylisoxazole, in the rat. Agric. Biol. Chem., 38(12):2451-2456.

Andrade, P.S.L., and W.B. Wheeler.
1973. Metabolism of mirex by sewage sludge organisms. Abstr. 166th ACS Meeting, Chicago, IL, PEST

Appleton, H.T., and T. Nakatsugawa.
1977. The toxicological significance of paraoxon deethylation. Pestic. Biochem. Physiol., 7:451-465.

Archer, T.E.
1976. Effects of light on the fate of carbofuran during the drying of alfalfa. J. Agric. Food Chem., 24(5):1057-1062.

Archer, T.E., and J.D. Stokes.
1978. Levels of β-naphthoxyacetic acid and β-naphthol on field sprayed strawberries as analyzed by high-pressure liquid chromatography. J. Agric. Food Chem., 26(6):1465-1466.

Archer, T.E., J.D. Stokes, and R.S. Bringhurst.
1977. Fate of carbofuran and its metabolites on strawberries in the environment. J. Agric. Food Chem., 25(3):536-541.

Ariaratnam, V., and G.P. Georghiou.
1975. Carbamate resistance in *Anopheles albimanus*. Bull. World Hlth. Organ., 52:91-96.

Arjmand, M.
1978. Identification, characterization, analytical techniques and biological activity of amino acid conjugates of chlorophenoxy herbicides. Dissert. Abstr., 37B(2):540.

Arjmand, M., R.H. Hamilton, and R.O. Mumma.
1978. Metabolism of 2,4,5-trichlorophenoxyacetic acid. Evidence for amino acid conjugates in soybean callus tissue. J. Agric. Food Chem., 26(5):1125-1128.

Arnold, H., F. Bourseaux, und N. Brock.
1958. Neuartige krebs-chemotherapeutika aus der gruppe der zyklischen N-lost-phosphamidester. Naturwissen., 45:64-67.

Arnold, H., und H. Klose.
1960. Die hydrolyse hexacyclischer N-lostphosphamidester im gepufferten system. Arzneim.-Forsch., 10:288-291.

Arnold, H., und H. Klose.
1961. Uber der hydrolytischen abbau des hexacyclischen *N*-lost-phosphamid-esters B 518 unter physiologischen bedingungen. Arzneim.-Forsch., 11:159-163.

Arnold, J.S.
1974. Some physical and chemical aspects of the adsorption of 4-amino-3,5,6-trichloropicolinic acid by soil and soil colloids. Dissert. Abstr., 35B(4):2540.

Asahi, Y., and T. Yoshida.
1977. Kinetics of hydrolyses of insecticides: Cartap hydrochloride and nereistoxin. Chem. Pharm. Bull., 25(9):2211-2216.

Asaka, S., N. Kawauchi, S. Koyama, and K. Emura.
1978. Fate of propaphos (Kayaphos) applied on seedling box. J. Pestic. Sci., 3:305-310.

Aschbacher, P.W., J.E. Bakke, and R.G. Zaylskie.
1978. Mass spectra of aniline glucuronides. Biomed. Mass Spectro., 5(6):409-412.

Aschbacher, P.W., and V.J. Feil.
1976. Mechanism of pentachloronitrobenzene in the goat. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 92.

Atallah, Y.H., H.W. Dorough, and J.H. Thorstenson.
1975. Nature and fate of insecticide residues inhaled by rats in cigarette smoke. Drug Metab. Dispos., 3(6):513-519.

Atallah, Y.H., D.M. Whitacre, and H.W. Dorough.
1976. Metabolism of the herbicide methazole in lactating cows and laying hens. J. Agric. Food Chem., 24(5):1007-1012.

Audley, B.G., B.L. Archer, and I.B. Carruthers.
1976. Metabolism of ethephon (2-chloroethylphosphonic acid) and related compounds in *Hevea brasiliensis*. Arch. Environ. Contam. Toxicol., 4:183-200.

Audley, B.G., and H.M. Wilson.
1978. Metabolism of 2-chloroethylphosphonic acid (ethephon) in suspension cultures of *Hevea brasiliensis*. J. Exper. Botany, 29(113):1329-1336.

Averitt, W.K., and E.O. Gangstad.
1976. Dissipation of residues of 2,4-D in static water. J. Environ. Qual., 5(2):145-147.

Avrahami, M., and D.A. White.
1976. Rapid elimination of pentachloronitrobenzene and metabolite from sheep fat. N.Z.J. Exper. Agric., 4:299-302.

Aziz, S.A., and C.O. Knowles.
1973. Oxythioquinox acaricide: Toxicological studies with two-spotted spider mites. J. Econ. Entomol., 66(5):1041-1045.

Babior, B.M., and K. Bloch.
1966. Aromatization of cyclohexanecarboxylic acid. J. Biol. Chem., 241(16):3643-3651.

Bachofer, R.
1976. Mikrobieller abbau von saureanilid-fungiziden (microbial breakdown of acid anilide fungicides). Zbl. Bakt. Hyg., I. Abt. Orig., B 162:153-156.

Bachofer, R., O. Oltmanns, and F. Lingens.
1973. Isolation and characterization of a *Nocardia*-like soil-bacterium, growing on carboxanilide fungicides. Arch. Mikrobiol., 90:141-149.

Baghos, V.B., W. Tadros, N.Z. Soliman, and H.W. Abdel-Sayed.
1977a. Reactions of halogenated insecticides with aromatic amines: Part II - Reactions of 1,1-bis(*p*-substituted-phenyl)-2,2,2-trichloroethanes with substituted dimethylanilines. Indian J. Chem., 15B:364-367.

Baghos, V.B., W. Tadros, N.Z. Soliman, and Y.S. Mohareb.
1977b. Reactions of halogenated insecticides with aromatic amines: Part III - Reactions of 1,1-bis(*p*-substituted-phenyl)-2,2,2-trichloroethanes with *N*,*N*-dialkylanilines. Indian J. Chem., 15B: 368-371.

Bai, K.M., H.M. Bhavnagary, and S.K. Majumder.
1978. Enhancement of toxicity to roof rats (*Rattus rattus*) by *in vitro* conversion of magnesium ammonium arsenate to arsenite salts. Comp. Physiol. Ecol., 3(3):155-161.

Baker, P.B., and D.R. Woods.
1977. Co-metabolism of the ixodicide amitraz. J. Appl. Bacteriol., 42:187-196.

Bakke, J.E., V.J. Feil, C.E. Fjelstul, and E.J. Thacker.
1972. Metabolism of cyclophosphamide by sheep. J. Agric. Food Chem., 20(2):384-388.

Bakke, J.E., V.J. Feil, and C.E. Price.
1976a. Replacement of a chlorine with a methylsulfonyl group in the metabolism of propachlor (2-chloro-*N*-isopropylacetanilide). Biomed. Mass Spectro., 3:226-229.

Bakke, J.E., V.J. Feil, and C.E. Price.
1976b. Rat urinary metabolites from *O*,*O*-diethyl-*O*-(3,5,6-trichloro-2-pyridyl)phosphorothioate. J. Environ. Sci. Hlth, B11(3):225-230.

Bakke, J.E., V.J. Feil, and C.E. Price.
1977a. Metabolism of triphenyltinhydroxide by the cow, sheep and rat. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 46.

Bakke, J.E., V.J. Feil, C.E. Price, and R.G. Zaylskie.
1976c. Metabolism of [^{14}C]crufomate (4-*t*-butyl-2-chlorophenyl methyl methylphosphoramidate) by the sheep. Biomed. Mass Spectro., 3:299-315.

Bakke, J.E. V.J. Feil, and R.G. Zaylskie.
1971. Characterization of the major sheep urinary metabolites of cyclophosphamide, a defleecing chemical. J. Agric. Food Chem., 19:788-790.

Bakke, J.E., G.L. Larsen, V.J. Feil, and C.E. Price.
1977b. Rat urinary metabolites from 2-chloro-*N*-isopropylacetanilide (Propachlor). Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 45.

Bakke, J.E., and C.E. Price.
1976. Metabolism of *O*,*O*-dimethyl-*O*-(3,5,6-trichloro-2-pyridyl) phosphorothiolate in sheep and rats and of 3,5,6-trichloro-2-pyridinol in sheep. J. Environ. Sci. Hlth., B11(1):9-22.

Bakke, J.E., and C.E. Price.
1977. Metabolism of crufomate [(4-*tert*-butyl-2-chlorophenylmethyl methylphosphoramidate)] by the rat. J. Environ. Sci. Hlth., B12 (4):251-260.

Bakke, J.E., C.E. Price, and R.G. Zaylskie.
1976d. Mass spectral characterization of the glucuronide conjugates of crufomate (4-*t*-butyl-2-chlorophenyl methyl methylphosphoramidate) metabolites. Biomed. Mass Spectro., 3:329-334.

Balba, H.M., and J.G. Saha.
1978. Studies on the distribution, excretion, and metabolism of α- and γ-isomers of [^{14}C]chlordane in rabbits. J. Environ. Sci. Hlth., B13(3):211-233.

Balba, H.M., G.G. Still, and E.R. Mansager.
1977. Studies on bound residues of chloroanilines in plants. Abstr. 174th ACS Meeting, Chicago, IL, PEST 14.

Baldwin, M.K., D. Bennett, and K.I. Beynon.
1977. The concentrations of aldrin and dieldrin and their photoisomers in the atmosphere. Pestic. Sci., 8:431-445.

Baldwin, M.K., J.V. Crayford, D.H. Hutson, and D.L. Street.
1976. The metabolism and residues of [^{14}C]endrin in lactating cows and laying hens. Pestic. Sci., 7:575-594.

Ballschmiter, K., C. Unglert, and H.J. Neu.
1977. Abbau von chlorierten aromaten: Mikrobiologischer abbau der polychlorierten biphenyle (PCB) - III. Chlorierte benzoesauren als metabolite der PCB. Chemosphere 6(1):51-56.

Barik, S., and N. Sethunathan.
1978a. Biological hydrolysis of parathion in natural ecosystems. J. Environ. Qual., 7(3):346-348.

Barik, S., and N. Sethunathan.
1978b. Metabolism of nitrophenols in flooded soils. J. Environ. Qual., 7(3):349-352.

Barringer, D.F., Jr., H.H. North, M.W. Bullock, and R.C. Blinn.
1978. Nature of the residues found in soil treated with Counter soil insecticide (Terbufos). Abstr. 175th ACS Meeting, Anaheim, CA, PEST 51.

Bartl, P., und F. Korte.
1975a. Beitrage zur okologischen chemie XCVIII. Photochemisches verhalten des herbizids sencor (4-amino-6-*tert*-butyl-3-(methylthio)-1,2,4-triazin-5-(4H)-on) in Losung. Chemosphere, 4(3):169-172.

Bartl, P., und F. Korte.
1975b. Beitrage zur okologischen chemie IC. Photochemisches und thermisches verhalten des herbizids sencor (4-amino-6-*tert*-butyl-3-(methylthio)-1,2,4-triazin-5-(4H)-on) als festkorper und auf oberflachen. Chemosphere, 4(3):173-176.

Basedow, S.-R. v.
1846. Arsenikdunst in Wohnzimmern. Schmidt's Jahrbucher, 52:89-91.

Bastide, J., and C. Coste.
1978. Cinetique de degradation chimique du propyzamide (Kerb) en milieu aqueux. I. Influence du pH et d'oligo-elements. Weed Res., 18:49-55.

Bates, J.J.
1973. Oxycarboxin: Site of action, mode of action and degradation. Dissert. Abstr., 33B(9):4067.

Batterby, S., G.N.J. Le Patourel, and D.J. Wright.
1977. Accumulation and metabolism of aldicarb by the free-living nematodes *Aphelenchus avenae* and *Panagrellus redivivus*. Ann. Appl. Biol., 86:69-76.

Beall, M.J., Jr.
1976. Persistence of aerially applied hexachlorobenzene on grass and soil. J. Environ. Qual., 5(4):367-369.

Beauford, W., J. Barber, and A.R. Barringer.
1977. Uptake and distribution of mercury within higher plants. Physiol. Plant., 39:261-265.

Bedford, C.T., M.J. Crawford, and D.H. Hutson.
1975a. Sulphoxidation of cyanatryn, a 2-mercapto-*SYM*-triazine herbicide, by rat liver microsomes. Chemosphere, 5(5):311-316.

Bedford, C.T., J.V. Crayford, D.H. Hutson, and D.E. Wiggins.
1978. An example of the oxidative de-esterification of an isopropyl ester. Its role in the metabolism of the herbicide flamprop-isopropyl. Xenobiotica, 8(6):383-395.

Bedford, C.T., R.K. Harrod, E.C. Hoadley, and D.H. Hutson.
1975b. The metabolic fate of endrin in the rabbit. Xenobiotica, 5(8):485-500.

Belal, M.H., H.S.M. Fahmy, M.D. Abdallah, and T.M. Awad.
1978. A note on the persistence of phosfolan on cotton leaves and glass surfaces under field conditions. Pestic. Sci., 9:63-64.

Beland, F.A., S.O. Farwell, A.E. Robocker, and R.D. Geer.
1976. Electrochemical reduction and anaerobic degradation of lindane. J. Agric. Food Chem., 24(4):753-756.

Belles, W.S., and R.A. Smith.
1973. Dinitramine uptake, translocation, and metabolism in soybeans. Abstr. Weed Sci. Soc. Amer., 61.

Ben-Aziz, A., and N. Aharonson.
1974. Persistence of benzimidazole derivatives in plants. Environ. Qual. Safety., 3(Suppl.):135-139.

Ben-Bassat, D., and A.M. Mayer.
1977. Reduction of mercury chloride by Chlorella: Evidence for a reducing factor. Physiol. Plant., 40:157-162.

Bencko, V., B. Benes, and M. Cikrt.
1976. Biotransformation of As(III) to As(V) and arsenic tolerance. Arch. Toxciol., 36:159-162.

Benezet, H.J., and C.O. Knowles.
1976. N'-(4-Chloro-o-tolyl)-N-methylformamidine (demethylchlordimeform) metabolism in the rat. J. Agric. Food Chem., 24(1):152-154.

Benezet, H.J., C.O. Knowles, J.R. Campbell, and J.E. Savage.
1978. Excretion balance, metabolic fate, and tissue residues following treatment of lactating goats and laying hens with thidiazuron cotton defoliant. J. Agric. Food Chem., 26(3): 622-627.

Berard, D.F., D.P. Rainey, and C.C. Lin.
1978. Absorption, translocation, and metabolism of fluridone in selected crop species. Weed Sci., 26(3):252-254.

Berlin, M., J. Carlson, and T. Norseth.
1975. Dose-dependence of methylmercury metabolism. Arch. Environ. Hlth., 30:307-313.

Bernhard, K.
1937. Stoffwechselversuche zur dehydrierung des cyclohexanringes. Z. Physiolog. Chem., 248:256-276.

Berninger, V.H., R. Ammon, und I. Berninger.
1968. Spektrophotometrische identifizierungen von hydroxyderivaten des biphenyls. Arzneim. Forsch., 18:880-886.

Beroza, M., and A.B. Borkovec.
1964. The stability of tepa and other aziridine chemosterilants. J. Medicinal Chem., 7:44-49.

Berry, J.D., and D.A. Stotter.
1977. Dechlorination of DDT by vitamin B_{12} under mildly reducing conditions. Chemosphere, 6(11):783-787.

Best, J.A.
1974. The effect of soil pH on *s*-triazine dissipation using a balance-sheet approach. Dissert Abstr. 34B(9):4155.

Betts, P.M., C.W. Giddings, and J.R. Fleeker.
1976. Degradation of 4-aminopyridine in soil. J. Agric. Food Chem., 24(3):571-574.

Beynon, K.I., K.E. Elgar, B.L. Mathews, and A.N. Wright.
1973. The analysis of crops to determine neutral conjugates of an *N*-hydroxymethyl derivative of monocrotophos insecticide. Analyst, 98:194-210.

Bhagwat, V.M., and B.V. Ramachandran.
1975. Malathion A and B esterases of mouse liver-I. Separation and properties. Biochem. Pharmacol., 24:1713-1717.

Biginelli, P.
1900a. Composizione e costituzione chimica del gas arsenicale delle tappezzerie. Atti Reale Accademia Dei Lincei. Series 5, 9:210-214.

Biginelli, P.
1900b. Composizione e constuzione chimica del gas arsenicale delle tapperzzerie. Atti Reale Accademia Dei Lincei. Series 5, 9:242-249.

Biginelli, P.
1901. Composizione e Costituzione chimica del gas arsenicale delle tappezzerie. Gazetta chim. Ital., 31(Part 1, Fasc. 1):58-73.

Bigley, W.S., and F.W. Plapp, Jr.
1978. Metabolism of *cis*- and *trans*-[^{14}C]permethrin by the tobacco budworm and the bollworm. J. Agric. Food Chem., 26(5):1128-1134.

Bingham, S.W., and R.L. Shaver.
1977. Diphenamid removal from water and metabolism by aquatic plants. Pestic. Biochem. Physiol., 7:8-15.

Binkley, R.W., G.L. Kirstner, V.C. Opaskar, and P. Olynyk.
1977a. Photochemical reaction of 2,4,5,6-tetrachloroisophthalonitrile. Chemosphere, 4:163-166.

Binkley, R.W., C.-Y.J. Tu, and J.C. Johnston.
1977b. Photochemical reaction of 4-hydroxy-2,5,6-trichloroisophthalonitrile. Chemosphere, 6(12):793-796.

Binning, A., F.J. Darby, M.P. Heenan, and J.N. Smith.
1967. The conjugation of phenols with phosphate in grass grups and flies. Biochem. J., 103:42-48.

Black, J.G., W.E. Sprott, D. Howes, and T. Rutherford.
1974. Percutaneous absorption of hexachlorophene. Toxicol., 2:127-139.

Blair, E.H.
1974. Biodegradation of tricyclohexyltin hydroxide. Environ. Qual. Safety, 3(Suppl.):406-409.

Blakley, E.R.
1974. The microbial degradation of cyclohexanecarboxylic acid: A pathway involving aromatization to form p-hydroxybenzoic acid. Can. J. Microbiol., 20:1297-1306.

Blakley, E.R.
1978. The microbial degradation of cyclohexanecarboxylic acid by a β-oxidation pathway with simultaneous induction to the utilization of benzoate. Can. J. Microbiol., 24(7):847-855.

Blanke, R.V., M.W. Fariss, P.S. Guzelian, A.R. Paterson, and D.E. Smith.
1978. Identification of a reduced form of chlordecone (Kepone) in human stool. Bull. Environ. Contam. Toxicol., 20:782-785.

Blasco, F., C. Gaudin, and R. Jeanjean.
1971. Absorption des ions arseniate par les chlorelles. Reduction partielle de l'arseniate en arsenite. C.R. Hebd. Seances Acad. Sci. (Paris) Ser. D. Sci. Nat., 273:812-815.

Blase, B.W., and T.A. Loomis.
1976. The uptake and metabolism of carbaryl by isolated perfused rabbit lung. Toxicol. Appl. Pharmacol., 37:481-490.

Bloomberg, J.R., and L.M. Wax.
1978. Metabolism of mefluidide in soybean and common cocklebur (Xanthium pensylvanicum Wallr.). Abstr. Weed Sci. Soc. Amer., 71.

Bock, K.-D., R. Bock, H. Fischer, S. Gorbach, and W.G. Thier.
1974. Triazophos (active substance in the sales product Hostathion) environmental impact (degradation on/in plants, in soil and in warm-blooded animals). Environ. Qual. Safety, 3(Suppl.):833-839.

Bock, R., and W. Thier.
1976. Metabolism and fate of triazophos in rats. Pestic. Sci., 7:307-314.

Boguszewski, Chr., und H.R. Schutte.
1978. Uber aufnahme und verteilung von camposan in roggen. Arch. exper. Vet. med., 32(4):593-599.

Bollag, J.-M., S.-Y. Liu, and R.D. Minard.
1978. Enzymatic cross-coupling between pesticide intermediates and naturally occurring compounds. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), No. V-604.

Booth, G.M., and D. Ferrell.
1977. Environmental behavior of dimilin. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 51.

Borchard, R.E., M.E. Welborn, L.G. Hansen, R.P. Link, and R.H. Teske.
1976. Apparent pharmacokinetics of PCB components in growing pigs and lambs when fed a ration containing Aroclor 1254. Arch. Environ. Contam. Toxicol., 4:226-245.

Borsetti, A.P., and J.A.G. Roach.
1978. Identification of kepone alteration products in soil and mullet. Bull. Environ. Contam. Toxicol., 20:241-247.

Botre, C., A. Memoli, and F. Alhaique.
1978. TCDD solubilization and photodecomposition in aqueous solutions. Environ. Sci. Tech., 12(3):335-336.

Bourquin, A.W.
1977. Degradation of malathion by salt-marsh microorganisms. Appl. Environ. Microbiol., 33(2):356-362.

Bowers, J.B., C.J. Soderquist, and D.G. Crosby.
1976. Distribution and fate of molinate in a rice field. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 66.

Bowker, D.M., and J.E. Casida.
1969. Metabolism of the acaricide chemical, fenazaflor (5,6-dichloro-1-phenoxycarbonyl-2-trifluoromethylbenzimidazole), and related 2-trifluoromethylbenzimidazoles in certain mammals, insects, and plants. J. Agric. Food Chem., 17(5):956-966.

Bowman, M.C., C.L. Holder, and L.G. Rushing.
1978. Trace analysis of etrimfos and two degradation products in corn and alfalfa. J. Agric. Food Chem., 26(1):35-42.

Bowmer, K.H., and M.L. Higgins.
1976. Some aspects of the persistence and fate of acrolein herbicide in water. Arch. Environ. Contam. Toxicol., 5:87-96.

Boyd, M.R., and R.A. Neal.
1976. Studies on the mechanism of toxicity and of development of tolerance to the pulmonary toxin, α-naphthylthiourea (ANTU). Drug Metab. Dispos., 4(4):314-322.

Bradway, D.E., and T.M. Shafik.
1977. Malathion exposure studies. Determination of mono- and dicarboxylic acids and alkyl phosphates in urine. J. Agric. Food Chem., 25(6):1342-1344.

Bradway, D.E., T.M. Shafik, and E.M. Lores.
1977. Comparison of cholinesterase activity, residue levels, and urinary metabolite excretion of rats exposed to organophosphorus pesticides. J. Agric. Food Chem., 25(6):1353-1358.

Braman, R.S., and C.C. Foreback.
1973. Methylated forms of arsenic in the environment. Science, 182:1247-1249.

Braun, W.H., and M.W. Sauerhoff.
1976. The pharmacokinetic profile of pentachlorophenol in monkeys. Toxicol. Appl. Pharmacol., 38:525-533.

Braun, W.H., J.D. Young, G.E. Blau, and P.J. Gehring.
1977. The pharmacokinetics and metabolism of pentachlorophenol in rats. Toxicol. Appl. Pharmacol., 41:395-406.

Braunberg, R.C., R.E. Dailey, E.A. Brouwer, L. Kasza, and A.M. Blaschka.
1976. Acute, subacute, and residual effects of polychlorinated biphenyl (PCB) in rats. I. Biologic half-life in adipose tissue. J. Toxicol. Environ. Hlth., 1:683-688.

Brewster, D., R.S. Jones, and D.V. Parke.
1977a. The metabolism of cyclohexanecarboxylate in the rat. Biochem. J., 164:595-600.

Brewster, D., R.S. Jones, and D.V. Parke.
1977b. The metabolism of cyclohexanecarboxylic acid in the isolated perfused rat liver. Xenobiotica, 7(10):601-609.
Briggs, G.G., and N. Walker.
1973. Microbial metabolism of 4-chloroaniline. Soil Biol. Biochem., 5:695-697.
Brimfield, A.A., J.C. Street, J. Futrell, and D.A. Chatfield.
1978. Identification of products arising from the metabolism of *cis*- and *trans*-chlordane in rat liver microsomes *in vitro*: Outline of a possible metabolic pathway. Pestic. Biochem. Physiol., 9:84-95.
Bristol, D.W., A.M. Ghanuni, and A.E. Oleson.
1976. Metabolism of 2,4-D in wheat cell suspension culture. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 105.
Bristol, D.W., A.M. Ghanuni, and A.E. Oleson.
1977. Metabolism of 2,4-dichlorophenoxyacetic acid by wheat cell suspension cultures. J. Agric. Food Chem., 25(6):1308-1314.
Brock, N., and H.-J. Hohorst.
1967. Metabolism of cyclophosphamide. Cancer, 20:900-904.
Brockman, F.E., and W.B. Duke.
1977. Degradation and leaching of methazole in soil. Weed Sci., 25(4):304-308.
Brookes, R.F., and L.G. Copping.
1975. Some chemical and physical properties of epronaz, a new herbicide. Pestic. Sci., 6:665-673.
Brown, M.J., and I.H. Williams.
1976. Determination of residues of isofenphos and its phosphor amidate analogue. Pestic. Sci., 7:545-548.
Brown, N.P.H.
1978. Private communication in Grayson, B.T., and S. Stokes. Pestic. Sci., 9:595-602.
Brown, R.A., C.M. Nazario, R.S. de Tirado, J. Castrillon, and E.T. Agard.
1977. A comparison of the half-life of inorganic and organic tin in the mouse. Environ. Res., 13:56-61.
Buhmann, U., G.-A. Hoyer, and H.R. Kruger.
1978. Photochemical behaviour of thidiazuron in aqueous solution. Abstr. 4th Internat. Congr. Pestic. Chem. (IUPAC) Zurich, V-603.
Bull, D.L.
1973. Metabolism of chlordimeform in cotton plants. Environ. Entomol., 2(5):869-871.
Bull, D.L., and A.B. Borkovec.
1973. Metabolism of carbon-14-labeled hempa by adult boll weevils. Arch. Environ. Contam. Toxicol., 1(2):148-158.
Bull, D.L., and G.W. Ivie.
1976. Metabolism of *O*-ethyl *O*-[4-(methylthio)phenyl] *S*-propyl phosphorodithioate (BAY NTN 9306) by white rats. J. Agric. Food Chem., 24(1):143-146.

Bull, D.L., and G.W. Ivie.
1978. Fate of diflubenzuron in cotton, soil, and rotational crops. J. Agric. Food Chem., 26(3):515-520.

Bull, D.L., C.J. Whitten, and G.W. Ivie.
1976. Fate of *O*-ethyl *O*-[4-(methylthio)phenyl] *S*-propyl phosphorodithioate (BAY NTN 9306) in cotton plants and soil. J. Agric. Food Chem., 24(3):601-605.

Bunce, N.J.
1978. Photolysis of 2-chlorobiphenyl in aqueous acetonitrile. Chemosphere, 7(8):653-656.

Bunce, N.J., S. Safe, and L.O. Ruzo.
1975. Photochemistry of bromobiphenyls: Steric effects and electron transfer. J. Chem. Soc., 1607-1610.

Burke, M.D., and J.W. Bridges.
1975. Biphenyl hydroxylations and spectrally apparent interactions with liver microsomes from hamsters pre-treated with phenobarbitone and 2-methylcholanthrene. Xenobiotica, 5(6):357-376.

Burke, M.D., and R.T. Mayer.
1975. Inherent specificities of purified cytochromes P-450 and P-448 toward biphenyl hydroxylation and ethoxyresorufin deethylation. Drug Metab. Dis., 3(4):245-253.

Burkhard, N., and J.A. Guth.
1976. Photodegradation of atrazine, atraton and ametryene in aqueous solution with acetone as a photosensitiser. Pestic. Sci., 7:65-71.

Burnside, O.C.
1974. Trifluralin dissipation in soil following repeated annual applications. Weed Sci., 22(4):374-377.

Burse, V.W., and E.C. Villanueva.
1976. PCB metabolism in rats following prolonged exposure to Aroclor 1242 and Aroclor 1016. Bull. Environ. Contam. Toxicol., 15(1):122-128.

Burt, M.E.
1977. Uptake, translocation, and metabolism of propham by wheat, sugarbeet, and alfalfa. Dissert. Abstr., 37B(11):5469.

Burt, M.E., and F.T. Corbin.
1978. Uptake, translocation, and metabolism of propham by wheat (*Triticum aestivum*, sugarbeet (*Beta vulgaris*), and alfalfa (*Medicago sativa*). Weed Sci., 26(3):296-303.

Buser, H., and H. Bosshardt.
1975. Studies on the possible formation of polychloroazobenzenes in quintozene treated soil. Pestic. Sci., 6:35-41.

Butts, E.R.
1976. Fate of bentazon in four Louisiana soils. Dissert. Abstr., 37B(5):2000.

Byast, T.H., and R.J. Hance.
1975. Degradation of 2,4,5-T by South Vietnamese soils incubated in the laboratory. Bull. Environ. Contam. Toxicol., 14(1):71-76.

Callaghan, J.J., M.D. Appleton, W. Haab, U. Burti, and C. Rubin.
1966. A study of the possible incorporation of ^{14}C labeled maleic hydrazide into the RNA of _Saccharomyces cerevisiae_. Pa. Acad. Sci., 39(2):311-317.

Calmon, J.-P., and D.R. Sayag.
1976a. Kinetics and mechanisms of conversion of methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate (Benomyl) to methyl 2-benzimidazolecarbamate (MBC). J. Agric. Food Chem., 24(2):311-314.

Calmon, J.-P., and D.R. Sayag.
1976b. Kinetics and mechanisms of conversion of methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate (benomyl) to 3-butyl-2,4-dioxo [1,2-a]-s-triazinobenzimidazole (STB) and 1-(2-benzimidazolyl)-3-_n_-butylurea (BBU). J. Agric. Food Chem., 24(2):314-317.

Calmon, J.-P., and D.R. Sayag.
1976c. Instability of methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate (benomyl) in various solvents. J. Agric. Food Chem., 24(2):426-428.

Campacci, E.F., P.B. New, and Y.T. Tchan.
1977. Isolation of amitrole-degrading bacteria. Nature, 266(5598): 164-165.

Cannizzaro, R.D.
1975. Residues of bentazon and its 6- and 8-hydroxylated metabolites in soybeans and soil. Abstr. Weed. Sci. Soc. Amer., 82.

Canton, J.H., R.C.C. Wegman, T.J.A. Vulto, C.H. Verhoef, and G.J. van Esch.
1978. Toxicity-, accumulation- and elimination studies of α-hexachlorocyclohexane (α-HCH) with saltwater organisms of different trophic levels. Water Res., 12:687-690.

Canty, A.J., and R. Kishimoto.
1977. Formation of diphenylmercury from phenylmercury(II) amino-acid complexes. Aust. J. Chem., 30:669-674.

Carey, A.E., and G.R. Harvey.
1978. Metabolism of polychlorinated biphenyls by marine bacteria. Bull. Environ. Contam. Toxicol., 20:527-534.

Carey, J.H., J. Lawrence and H.M. Tosine.
1976. Photodechlorination of PCB's in the presence of titanium dioxide in aqueous suspensions. Bull. Environ. Contam. Toxicol., 16(6):697-701.

Carlson, D.A., K.D. Konyha, W.B. Wheeler, and G.P. Marshall.
1976a. Mirex degradation in the environment to related compounds including kepone. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 108.

Carlson, D.A., K.D. Konyha, W.B. Wheeler, G.P. Marshall, and R.G. Zaylskie.
1976b. Mirex in the environment: Its degradation to kepone and related compounds. Science, 194:939-941.

Caro, J.H., A.W. Taylor, and H.P. Freeman.
1976. Comparative behavior of dieldrin and carbofuran in the field. Arch. Environ. Contam. Toxicol., 3(4):437-447.

Carringer, R.D., and C.E. Rieck.
1976. Soil degradation of VEL 5026. Abstr. Weed Sci. Soc. Amer., p 88.

Carringer, R.D., C.E. Rieck, and L.P. Bush.
1978. Metabolism of EPTC in corn (Zea mays). Weed Sci., 26(2): 157-160.

Casida, J.E., E.C. Kimmel, M. Lay, H. Ohkawa, J.E. Rodebush, R.A. Gray, C.K. Tseng, and H. Tilles.
1974. Thiocarbamate sulfoxide herbicides. Environ. Qual. Safety, 3(Suppl.):675-679.

Cavell, B.D., S.J. Pollard, and C.H.J. Wells.
1976. Photodimerisation of some systemic pyrimidine fungicides. Chem. Ind., 13:566-567.

Chadwick, R.W., C.J. Chadwick, J.J. Freal, and C.C. Bryden.
1977. Comparative enzyme induction and lindane metabolism in rats pretreated with various organochlorine pesticides. Xenobiotica, 7(4):235-246.

Chadwick, R.W., M.F. Cranmer, and A.J. Peoples.
1971. Comparative stimulation of γ-HCH metabolism by pretreatment of rats with γ-HCH, DDT, and DDT + γ-HCH. Toxicol. Appl. Pharmacol., 18:685-695.

Chadwick, R.W., J.J. Freal, G.W. Sovocool, C.C. Bryden, and M.F. Copeland.
1978. The identification of three previously unreported lindane metabolites from mammals. Chemosphere 7(8):633-640.

Chakrabarti, J.K., and O.M. Friedman.
1973. Studies on the hydrolysis of cyclophosphamide II. Isolation and characterization of intermediate hydrolytic products. J. Heterocycl. Chem., 10:55-58.

Challenger, F.
1945. Biological methylation. Chem. Rev., 36:315-361.

Challenger, F., and C. Higginbottom.
1935. CCVIII. The production of trimethylarsine by Penicillium brevicaule (Scopulariopsis brevicaulis). Biochem. J., 29:1757-1778.

Challenger, F., C. Higginbottom, and L. Ellis.
1933. The formation of organo-metalloidal compounds by microorganisms. Part I. Trimethylarsine and dimethylethylarsine. J. Chem. Soc., (Part I):95-101.

Chamberlain, W.F., and E.W. Hamilton.
1964. Absorption, excretion, and metabolism of P^{32}-labeled metepa by screw-worm and stable flies. J. Econ. Entom., 57(4):800-803.

Chamberlain, W.F., L.M. Hunt, D.E. Hopkins, A.R. Gingrich, J.A. Miller, and B.N. Gilbert.
1975. Absorption, excretion, and metabolism of methoprene by a guinea pig, a steer, and a cow. J. Agric. Food Chem., 23(4): 736-742.

Chambers, H., L.J. Dziuk, and J. Watkins.
1977. Hydrolytic activation and detoxication of 2,4-dichlorophenoxyacetic acid esters in mosquito fish. Pestic. Biochem. Physiol., 7:297-300.

Chambers, J.E.
1976. The relationship of esterases to organophosphorus insecticide tolerance in mosquitofish. Pestic. Biochem. Physiol., 6:517-522.

Chandurkar, P.S.
1978. Metabolism of toxaphene components in rats. Dissert. Abstr., 38B(10):4626-4627.

Chandurkar, P.S., and F. Matsumura.
1977. Metabolism of toxaphene in rats. Abstr. 174th ACS Meeting, Chicago, IL, PEST 29.

Chang, E.S., and J.D. O'Connor.
1978. *In vitro* secretion and hydroxylation of α-ecdysone as a function of the crustacean molt cycle. Gen. Comp. Endocrinol., 36:151-160.

Chang, K.-M.
1977. Toxicological studies of formamidine acaricides. Dissert. Abstr., 38B(2):495.

Chang, K.-M., and C.O. Knowles.
1977. Formamidine acaricides. Toxicity and metabolism studies with twospotted spider mites, *Tetranychus urticae* Koch. J. Agric. Food Chem., 25(3):493-501.

Chang, K.-M., and C.O. Knowles.
1978. Aldicarb metabolism in twospotted spider mites. J. Econ. Entomol., 71(2):158-160.

Chang, S.C.
1978. Conjugation: The major metabolic pathway of ^{14}C-diflubenzuron in the house fly. J. Econ. Entomol., 71(1):31-39.

Chang, S.C., and A.B. Borkovec.
1969. Comparative metabolism of ^{14}C-labeled hempa by house flies susceptible or resistant to isolan. J. Econ. Entom., 62(6):1417-1421.

Chang, S.C., A.B. Borkovec, and C.W. Woods.
1966. Fate of tepa uniformaly labeled with C^{14} in male house flies. J. Econ. Entom., 59(4):937-944.

Chang, S.C., A.B. DeMilo, C.W. Woods, and A.B. Borkovec.
1968. Metabolism of C^{14}-labeled hemel in male house flies. J. Econ. Entom., 61(5):1357-1365.

Chang, S.C., P.H. Terry, C.W. Woods, and A.B. Borkovec.
1967. Metabolism of hempa uniformly labeled with C^{14} in male house flies. J. Econ. Entom., 60(6):1623-1631.

Chang, S.C., C.W. Woods, and A.B. Borkovec.
1970. Metabolism of ^{14}C-labeled N^2,N^2,N^4,N^4-tetramethylmelamine in male house flies. J. Econ. Entom., 63(5):1510-1513.

Chen, P.R., J.D. McKinney, and H.B. Matthews.
1976. Metabolism of 2,4,5,2',5'-pentachlorobiphenyl in the rat, qualitative and quantitative aspects. Drug Metab. Dispos., 4(4):362-367.

Chen, Y.-L.
1978. Photodegradation and dissipation of herbicide butachlor in the environment. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), V-636.

Chen, Y.-L., and C.C. Chen.
1978. Photodecomposition of a herbicide, butachlor. J. Pestic. Sci., 3:143-148.

Chen, Y.-L., and T.C. Wu.
1978. Degradation of herbicide butachlor by soil microbes. J. Pestic. Sci., 3:411-417.

Chen, Y.S., and J.E. Casida.
1978a. Thiocarbamate herbicide metabolism: Microsomal oxygenase metabolism of EPTC involving mono- and dioxygenation at the sulfur and hydroxylation at each alkyl carbon. J. Agric. Food Chem., 26(1):263-267.

Chen, Y.S., and J.E. Casida.
1978b. Microsomal oxygenase metabolism of the thiocarbamate herbicide EPTC. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 40.

Cheng, H.H., F. Fuhr, H.J. Jarczyk, and W. Mittelstaedt.
1978. Degradation of methabenzthiazuron in the soil. J. Agric. Food Chem., 26(3):595-599.

Cheng, H.H., F. Fuhr, and W. Mittelstaedt.
1974. Fate of methabenzthiazuron in the plant-soil system. Environ. Qual. Safety, 3(Suppl.):271-276.

Cherrington, A.D., U. Paim, and O.T. Page.
1969. *In vitro* degradation of DDT by intestinal contents of Atlantic salmon (*Salmo salar*). J. Fish. Res. Bd. Canada, 26: 47-54.

Chiba, M.
1975. Rate of degradation of benomyl in common organic solvents and water. Abstr. 170th ACS Meeting, Chicago, IL, PEST 127.

Chiba, M.
1977a. Effects of temperature on the equilibrium of benomyl, and its degradation products methyl 2-benzimidazole carbamate and *n*-butyl isocyanate in benzene and chloroform. Bull. Environ. Contam. Toxicol., 18(3):285-290.

Chiba, M.
1977b. A rapid spectrophotometric method for the simultaneous determination of intact benomyl and its degradation product, methyl 2-benzimidazolecarbamate (MBC), in organic solvents and water. J. Agric. Food Chem., 25(2):368-373.

Chiba, M., and E.A. Cherniak.
1978. Kinetic study of reversible conversion of methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate (Benomyl) to methyl 2-benzimidazolecarbamate (MBC) and *n*-butyl isocyanate (BIC) in organic solvents. J. Agric. Food Chem., 26(3):573-576.

Chiba, M., S. Kato, and I. Yamamoto.
1976. Metabolism of cyanox and surecide in bean plants and degradation in soil. J. Pestic. Sci., 1:179-191.

Chin, W.-T., W.C. Duane, J.R. Meeks, and D.E. Stallard.
1976a. Changes of thiofanox residues in potatoes resulting from storage and cooking. J. Agric. Food Chem., 24(5):1001-1004.

Chin, W.-T., W.C. Duane, D.L. Ballee, and D.E. Stallard.
1976b. Mechanism of degradation of thiofanox in aqueous solutions. J. Agric. Food Chem., 24(5):1071-1073.

Chio, H., and J.R. Sanborn.
1976. The metabolism of ^{14}C-chlordane by the earthworm *Lumbricus terrestris* L. Chemosphere, 5(3):161-166.

Chio, H., and J.R. Sanborn.
1977. Atrazine inhibition of carbofuran metabolism in the house cricket. J. Econ. Entom., 70(5):544-546.

Chio, H., and J.R. Sanborn.
1978. The metabolism of atrazine, chloramben, and dicamba in earthworms (*Lumbricus terrestris*) from treated and untreated plots. Weed Sci., 26(4):331-335.

Chisholm, D.
1974. Persistence of fensulfothion in soil and uptake by rhutabagas and carrots. Can. J. Plant Sci., 54:667-671.

Chisholm, D.
1975. Persistence of chlorfenvinphos in soil and its uptake by some crops. Can. J. Soil Sci., 55:177-180.

Chisholm, D., and H.B. Specht.
1978. Residues and control of aphids on strawberries with banded surface applications of disulfoton. J. Econ. Entomol., 71(3): 469-472.

Chiu, T.Y., and R.C. Blinn.
1975. Metabolism of *O*,*O*,*O*',*O*'-tetramethyl-*O*,*O*'-thiodi-*p*-phenylene phosphorothioate (Temephos) dermally sprayed onto lactating goats. Abstr. 170th ACS Meeting, Chicago, IL, PEST 2.

Chiu, Y.C., A.L. Black, and T.R. Fukuto.
1975. Thiolysis as an activation process in *N*-sulfenylated derivatives of methylcarbamate esters. Pestic. Biochem. Physiol., 5:359-366.

Chkanikov, D.I., A.M. Makeyev, N.N. Pavlova, L.V. Grygoryeva, V.P. Dubovoi, and O.V. Klimov.
1976. Variety of 2,4-D metabolic pathways in plants; its significance in developing analytical methods for herbicides residues. Arch. Environ. Contam. Toxicol., 5:97-103.

Chopra, N.M., B.S. Campbell, and J.C. Hurley.
1978. Systematic studies on the breakdown of endosulfan in tobacco smokes: Isolation and identification of the degradation products from the pyrolysis of endosulfan I in a nitrogen atmosphere. J. Agric. Food Chem., 26(1):255-258.

Chopra, N.M., and A.M. Mahfouz.
1977a. Metabolism of endosulfan I, endosulfan II, and endosulfan sulfate in tobacco leaf. J. Agric. Food Chem., 25(1):32-36.

Chopra, N.M., and A.M. Mahfouz.
1977b. Further investigations into the metabolism of endosulfan I, endosulfan II, and endosulfan sulfate in tobacco leaf. Beitrage zur Tabakforschung, 9(3):176-179.

Chou., S.-F. J.
1978. Fate of acylanilides in soils and polybrominated biphenyls (PBB's) in soils and plants. Dissert. Abstr., 39B(1):22-23.

Chou, T.W., R. Spanggord, E. Shingai, and N. Bohonos.
1976. The fate of methyl parathion in freshwater systems: III. Biodegradation studies. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 62.

Choudhry, G.G., G. Sundstrom, L.O. Ruzo, and O. Hutzinger.
1977a. Photochemistry of chlorinated diphenyl ethers. J. Agric. Food Chem., 25(6):1371-1376.

Choudhry, G.G., G. Sundstrom, F.W.M. van der Wielen, and O. Hutzinger.
1977b. Synthesis of chlorinated dibenzofurans by photolysis of chlorinated diphenyl ethers in acetone solution. Chemosphere, 6:327-332.

Chu, I., D.C. Villeneuve, V. Secours, G.C. Becking, A. Viau, and F. Benoit.
1978. Metabolism and tissue distribution of photomirex in the rat. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 51.

Ciba-Geigy, A.G.
1976. Private communication from Morton, T.C., G. Holan and C.T.F. Virgona. Pestic. Biochem. Physiol., 6:209-214.

Clapp, D.W.
1974. Di-syston (O,O-diethyl S-[2-ethylthioethyl]phosphorodithioate) degradation in soil. Dissert. Abstr., 35(2):635-636.

Clapp, D.W., D.V. Naylor, and G.C. Lewis.
1976. The fate of disulfoton in portneuf silt loam soil. J. Environ. Qual., 5(2):207-210.

Clark, D.E., J.S. Palmer, R.D. Radeleff, H.R. Crookshank, and F.M. Farr.
1975. Residues of chlorophenoxy acid herbicides and their phenolic metabolites in tissues of sheep and cattle. J. Agric. Food Chem., 23(3):573-578.

Clark, T., D.R. Clifford, A.H.B. Deas, P. Gendle, and D.A.M. Watkins.
1973. Photolysis, metabolism and other factors influencing the performance of triadimefon as a powdery mildew fungicide. Pestic. Sci., 9:497-506.

Clark, T., and D.A.M. Watkins.
1978. Photolysis of dichlofluanid. Pestic. Sci., 9:225-228.

Coats, J.R.
1975. Toxicity and metabolism of three methoxychlor analogues with altered aliphatic moieties, and the development of some novel DDT analogues. Dissert. Abstr., 35B(7):3367-3368.

Cobby, J., M. Mayersohn, and S. Selliah.
1978. Disposition kinetics in dogs of diethyldithiocarbamate, a metabolite of disulfiram. J. Pharmacok. Biopharm., 6(5):369-387.

Cocks, J.A.
1975. Inhibition of carbaryl metabolism by nitrogen in three species of cockroach and one species of locust. Pestic. Sci., 6:259-265.

Cole, L.K., R.L. Metcalf, and J.R. Sanborn.
1976. Environmental fate of insecticides in terrestrial model ecosystems. Int. J. Environ. Studies, 10:7-14.

Colvin, M., C.A. Padgett, and C. Fenselau.
1973. A biologically active metabolite of cyclophosphamide. Cancer Res., 33:915-918.

Comer, S.W., H.E. Ruark, and A.L. Robbins.
1976. Stability of parathion metabolites in urine samples collected from poisoned individuals. Bull. Environ. Contam. Toxicol., 16(5):618-625.

Comes, R.D., V.F. Bruns, and A.D. Kelley.
1976. Residues and persistence of glyphosate in irrigation water. Weed Sci., 24(1):47-50.

Cook, G.H., and J.C. Moore.
1976. Determination of malathion, malaoxon, and mono- and dicarboxylic acids of malathion in fish, oyster, and shrimp tissue. J. Agric. Food Chem., 24(3):631-634.

Coppedge, J.R., D.L. Bull, and R.L. Ridgway.
1977. Movement and persistence of aldicarb in certain soils. Arch. Environ. Contam. Toxicol., 5(2):129-141.

Corbett, M.D., B.R. Chipko, and D.G. Baden.
1978. Chloroperoxidase-catalysed oxidation of 4-chloroaniline to 4-chloronitrosobenzene. Biochem. J., 175:353-360.

Corkins, H.G., L. Storace, and E. Osgood.
1978. Thermal decomposition of insecticides: A mechanistic investigation of the thermolysis of thiofanox. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 21.

Cortat, M.
1978. Studies on the mode of action of phenylmercuric borate on *Escherichia coli*. I. Structural localization and kinetics of incorporation. Zbl. Bakt. Hyg., I. Abt. Orig. B 166:517-527.

Courtney, G.F.
1977. Stability of thiophanate-methyl in aqueous dispersion. Pestic. Sci., 8:211-213.

Courtney, K.D., J.P. Putnam, and J.E. Andrews.
1978. Metabolic studies with TCDD (Dioxin) treated rats. Arch. Environ. Contam. Toxicol., 7:385-396.

Cox, D.P.
1974. Microbial methylation of arsenic. Abstr. 168th ACS Meeting, Atlantic City, NJ, PEST 14.

Cox, D.P., and M. Alexander.
1973. Production of trimethylarsine gas from various arsenic compounds by three sewage fungi. Bull. Environ. Contam. Toxicol., 9(2):84-88.

Cox, H.C., J.R. Young, and M.C. Bowman.
1967. Persistence of tepa in fall armyworm moths. J. Econ. Entom., 60:1111-1115.

Cox, J., and J.A. Pinegar.
1976. Benomyl residues in bananas. Pestic. Sci., 7:193-200.

Cox, P.J., P.B., Farmer, M. Jarman, R.W. Kinas, and W.J. Stec.
1978. Stereoselectivity in the metabolism of the enantiomers of cyclophosphamide in mice, rats, and rabbits. Drug Metab. Dispos., 6(6):617-622.

Cox, P.J., and L. Levin.
1975. Novel metabolic products of cyclophosphamide in human urine. Biochem. Pharmacol., 24:1233-1235.

Craig, A.W., and H. Jackson.
1955. The metabolism of ^{32}P-labeled triethylenephosphoramide in relation to its anti-tumour activity. Brit. J. Pharmacol., 10: 321-325.

Craig, P.J., and P.D. Bartlett.
1978. The role of hydrogen sulphide in environmental transport of mercury. Nature, 275(5681):635-637.

Crawford, M.J., J.V. Crayford, A. Croucher, and D.H. Hutson.
1978. Unpublished work in D.H. Hutson and J.E. Casida. Xenobiotica, 8(9):565-571.

Crawford, M.J., and D.H. Hutson.
1977. The metabolism of the pyrethroid insecticide (±)-α-cyano-3-phenoxybenzyl 2,2,3,3-tetramethylcyclopropanecarboxylate, WL 41706, in the rat. Pestic. Sci., 8:579-599.

Crawford, M.J., D.H. Hutson, and P.A. King.
1976. Metabolic demethylation of the insecticide dimethylvinphos in rats, in dogs, and *in vitro*. Xenobiotica, 6(12):745-762.

Crawford, M.J., D.H. Hutson, and G. Stoydin.
1975. Unpublished data from C.T. Bedford, M.J. Crawford and D.H. Hutson. Chemosphere, 5(5):311-316.

Crayford, J.V., P.A. Harthoorn, and D.H. Hutson.
1976. Excretion and residues of the herbicides benzoylprop-ethyl flamprop-isopropyl and flamprop-methyl in cows, pigs and hens. Pestic. Sci., 7:559-570.

Crecelius, C., and C.O. Knowles.
1976a. Unpublished results, 1975. In: C.O. Knowles, Chemistry and toxicology of quinoxaline, organotin, organofluorine, and formamidine acaricides. Environ. Hlth. Perspect., 14:93-102.

Crecelius, C.S., and C.O. Knowles.
1976b. Toxicity, penetration, and metabolism of chlordimeform and its *N*-demethyl metabolites in cabbage looper larvae. J. Agric. Food Chem., 24(5):1018-1023.

Crecelius, C.S., and C.O. Knowles.
1978. Excretion balance, metabolic fate, and tissue residues following treatment of rats with thidiazuron cotton defoliant. J. Agric. Food Chem., 26(2):486-494.

Crecelius, E.A.
1977. Changes in the chemical speciation of arsenic following ingestion by man. Environ. Hlth. Perspec., 19:147-150.

Cripe, C.R., and R.J. Livingston.
1977. Dynamics of mirex and its principal photoproducts in a simulated marsh system. Arch. Environ. Contam. Toxicol., 5:295-303.

Crofts, M., R.J. Harris, and R.J. Whiteoak.
1972. Determination of residues in apples and pears following treatment with the acaricide fenazaflor. I. Routine method for fenazaflor and major metabolites. Pestic. Sci., 3:29-37.

Crosby, D.G., and K.W. Moilanen.
1977. Vapor-phase photodecomposition of DDT. Chemosphere, 4:167-172.

Crosby, D.G., K.W. Moilanen, J.N. Seiber, C.J. Soderquist, and J.E. Woodrow.
1974. Photodecomposition of trifluralin vapor. Abstr. 167th ACS Meeting, Los Angeles, CA, PEST 70.

Crosby, D.G., and A.S. Wong.
1973. Photodecomposition of p-chlorophenoxyacetic acid. J. Agric. Food Chem., 21(6):1049-1054.

Crosby, D.G., and A.S. Wong.
1976. Photochemical generation of chlorinated dioxins. Chemosphere, 5:327-332.

Crosby, D.G., and A.S. Wong.
1977. Environmental degradation of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Science, 195:1337-1338.

Cross, R.J., and C.M. Jenkins.
1975. Chemical studies relating to environmental organomercurials. Environ. Pollut., 8:179-184.

Cuilbert, C.C., and A.E. Chung.
1974. Metabolism of cyclopropanecarboxylic acid. A new role for carnitine. J. Biol. Chem., 249(4):1026-1030.

Cullimore, D.R., and M. Kohout.
1974. Isolation of a bacterial degrader of the herbicide bromoxynil from a Saskatchewan soil. Can. J. Microbiol., 20:1449-1452.

Daly, R.W. Jr.
1972. Degradation of 2,4-DBEE in an aquatic environment. Dissert. Abstr., 32B(7):3806.

Darda, S.
1977. Absorption, metabolism and excretion of the fungicide triforine in the rat. Pestic. Sci., 8:193-202.

Darda, S., R.L. Darskus, D. Eichler, W. Ost, and M. Wotschokowsky.
1977. Hydrolysis and photolysis of the fungicide triforine. Pestic. Sci., 8:183-192.

Darrow, D.C., and G.C. Harding.
1975. Accumulation and apparent absence of DDT metabolism by marine copepods, *Calanus* spp., in culture. J. Fish. Res. Bd. Canada, 32(10):1845-1849.

Daughton, C.G., and D.P.H. Hsieh.
1977a. Parathion utilization by bacterial symbionts in a chemostat. Appl. Environ. Microbiol., 34(2):175-184.

Daughton, C.G., and D.P.H. Hsieh.
1977b. Accelerated parathion degradation in soil by inoculation with parathion-utilizing bacteria. Bull. Environ. Contam. Toxicol., 18(1):48-56.

Davidek, J., and J. Seifert.
1975. The interaction of folpet with the gluthathione-dependent demethylation enzyme system of rat liver. Pestic. Biochem. Physiol., 5:552-556.

Davidonis, G.H., R.H. Hamilton, and R.O. Mumma.
1978. Metabolism of 2,4-dichlorophenoxyacetic acid in soybean root callus and differentiated soybean root cultures as a function of concentration of tissue age. Plant Physiol., 62:80-83.

Davidse, L.C.
1976. Metabolic conversion of methyl benzimidazol-2-yl carbamate (MBC) in *Aspergillus nidulans*. Pestic. Biochem. Physiol., 6:538-546.

Davidse, L.C., and W. Flach.
1977. Differential binding of methyl benzimidazol-2-yl carbamate to fungal tubulin as a mechanism of resistence to this antimitotic agent in mutant strains of *Aspergillus nidulans*. J. Cell Biol., 72:174-193.

Davis, D.G., R.H. Hodgson, K.E. Dusbabek, and B.L. Hoffer.
1978. The metabolism of the herbicide diphenamid (*N*,*N*-dimethyl-2,2-diphenyl-acetamide) in cell suspensions of soybean (*Glycine max*). Physiol. Plant., 44:87-91.

Davis, J.E., and T.J. Mende.
1977. A study of the binding of sulfur to rat liver microsomes which occurs concurrently with the metabolism of *O*,*O*-diethyl *O*-*p*-nitrophenyl phosphorothioate (parathion) to *O*,*O*-diethyl *O*-*p*-nitrophenyl phosphate (paraoxon). J. Pharmacol. Exp. Thera., 201(2): 490-497.

Davison, K.L.
1976. Carbon-14 distribution and elimination in chickens given methoprene-^{14}C. J. Agric. Food Chem., 24(3):641-643.

Dawson, A.J.
1977. The metabolism of monuron, 3-(4-chlorophenyl)-1,1-dimethylurea, by *Citrus sinensis* (L.) Osbeck CV Koethen. Dissert. Abstr., 38B(1):13.

Deacon, G.B.
1978. Volatilisation of methylmercuric chloride by hydrogen sulphide. Nature, 275:344.

Dean-Raymond, D., and M. Alexander.
1977. Bacterial metabolism of quaternary ammonium compounds. Appl. Environ. Microbiol., 33(5):1037-1041.

DeBaun, J.R., D.L. Bova, K.A. Finley, and J.J. Menn.
1978a. Metabolism of [ring-^{14}C]ordram (molinate) in the rat. 1. Balance and tissue residue study. J. Agric. Food Chem., 26(5):1096-1098.

DeBaun, J.R., D.L. Bova, C.K. Tseng, and J.J. Menn.
1978b. Metabolism of [ring-^{14}C]ordram (molinate) in the rat. 2. Urinary metabolite identification. J. Agric. Food Chem., 26(5):1098-1104.

DeBaun, J.R., D.L. Bova, C.K. Tseng, and J.J. Menn.
1978c. Metabolism of the rice herbicide, ordram (molinate), in the rat. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-5.

DeBaun, J.R., and J.J. Menn.
1976. Sulfoxide reduction in relation to organophosphorus insecticide detoxification. Sci., 191:187-188.

Deckert, F.W.
1973. Warfarin metabolism in the guinea pig. I. Pharmacological studies. Drug Metab. Dis., 1(5):704-710.

Dedek, W., and W. Georgi.
1978. Comparative degradation and metabolism of butonate, trichlorphone and dichlorvos. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-516.

Dedek, W., R. Grahl, und H. Schwarz.
1978a. Metabolismus und ausscheidung von ^{32}P-aminophon am laktie-renden rind. Arch. exper. Vet. med., 32(2):239-245.

Dedek, W., R. Grahl, H. Schwarz, und P. Ludwig.
1978b. Metabolismus, ruckstande und ausscheidung des anthelminthikums ^{131}J-rafoxanid in blut, milch, fleisch und urin am laktierenden rind. Arch. exper. Vet med., 32:951-955.

Dedek, W., K. Lohs, G.W. Fischer, and R. Schmidt.
1976a. Alkylation of guanine in mice *in vivo* by organophosphorus insecticides. I. Trichlorphone and butonate. Pestic. Biochem. Physiol., 6:101-110.

Dedek, W., H. Schwarz, and E. Liebaug.
1976b. Untersuchungen zum abbau und zur ausscheidung des anthelminthikums ^{131}J-Rafoxanid an rind und schaf. Arch. Exper. Vet. Med., 30(3):423-426.

Dedek, W., H. Schwarz, and E. Liebaug.
1977. Abbau und ruckstandsdynamik des anthelminthikums ^{131}J-Rafoxanid in blut, milch, fleisch und fett bei unterschiedlicher dosierung am rind. (Degradation and dynamics of residues of the anthelminthic ^{131}J-Rafoxanide in blood, milk, meat and fat following different dosages on cattle.) Arch. Exp. Veterinarmed., 31(3): 365-368.

de Filippis, L.F.
1978. The effect of sub-lethal concentrations of mercury and zinc on Chlorella. IV. Characteristics of a general reducing enzyme system for metallic ions. Z. Pflanzenphysiol., 86:339-352.

de Filippis, L.F., and C.K. Pallaghy.
1975. A simple model for the non-enzymatic reduction and alkylation of mercuric salts in biological systems. Bull. Environ. Contam. Toxicol., 14(1):32-37.

Dejonckheer, W., W. Steurbaut, and R.H. Kips.
1976. Residues of quintozene, its contaminants and metabolites in soil, lettuce, and Witloof-chicory, Belgium-1969-74. Pestic. Monit. J., 10(2):68-73.

Dennis, W.H., Jr., and W.J. Cooper.
1975. Catalytic dechlorination of organochlorine compounds. I. DDT. Bull. Environ. Contam. Toxicol., 14(6):738-745.

Dennis, W.H., Jr., and W.J. Cooper.
1976. Catalytic dechlorination of organochlorine compounds. II. Heptachlor and chlordane. Bull. Environ. Contam. Toxicol., 16(4):425-430.

Dennis, W.H., Jr., and W.J. Cooper.
1977. Catalytic dechlorination of organochlorine compounds. III. Lindane. Bull. Environ. Contam. Toxicol., 18(1):57-59.

Deo, P.G., and M. Alexander.
1976. Ring hydroxylation of p-chlorophenylacetate by an Arthrobacter strain. Appl. Environ. Microbiol., 32(1):195-196.

Dequidt, J., F. Erb, J. Pommery.
1976. Etude toxicologique experimentale de quelques isomeres du trichlorobiphenyle. European J. Toxicol., 9(1):23-29.

de Saint Blanquat, G., G. Vidaillac, A. Lindenbaum, and R. Derache.
1976. Absorption digestive, fixation tissulaire et excretion du disulfirame administre oralement chez le rat. Arch. Int. Pharmacodyn., 223(2):339-350.

Deuel, L.E.
1975. Residue levels of propanil, molinate, carbofuran, carbaryl, and their respective metabolites in rice paddy water. Dissert. Abstr., 36B(5):1997-1998.

Deuel, L.E., K.W. Brown, F.C. Turner, D.G. Westfall, and J.D. Price.
1977. Persistence of propanil, DCA, and TCAB in soil and water under flooded rice culture. J. Environ. Qual., 6(2):127-132.

DeVita, V.T., and R.H. Adamson.
1970. The metabolism of ^{14}C cyclophosphamide: Comparative drug metabolism studies on African and American patients with lymphosarcoma and Burkitt's tumor. Internat. Cong. Chemothera. Proc., 2:218-225.

Dickens, F.
1947. Aromatization of cyclohexane carboxylate in liver slices. Nature, 159(4051):839.

Dishburger, H.J., R.L. McKellar, J.Y. Pennington, and J.R. Rice.
1977. Determination of residues of chlorpyrifos, its oxygen analogue, and 3,5,6-trichloro-2-pyridinol in tissues of cattle fed chlorpyrifos. J. Agric. Food Chem., 25(6):1325-1329.

Dizikes, L.J., W.P. Ridley, and J.M. Wood.
1978. A mechanism for the biomethylation of tin by reductive Co-C bond cleavage of alkylcobalamins. J. Amer. Chem. Soc., 100(3):1010-1012.

Doherty, M., and M.A.Q. Khan.
1978. Characteristics of hepatic mixed function oxidase in the amphibian, *Xenopus laevis*. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 41.

Domir, S.C.
1975. Absorption, movement and fate of ethephon as a maturing agent in flue-cured tobacco. Dissert. Abstr. 35(12):5727.

Domir, S.C.
1978. Translocation and metabolism of injected maleic hydrazide in silver maple and American sycamore seedlings. Physiol. Plant., 42:387-390.

Domir, S.C., and G.K. Brown.
1978. Distribution and metabolic fate of [^{14}C]-daminozide injected into silver maple and American sycamore seedlings. Pestic. Sci., 9:27-32.

Domir, S.C., and C.L. Foy.
1975. A study of ^{14}C-ethylene and ^{14}CO$_2$ evolution from ^{14}C-ethephon. Abstr. 170th ACS Meeting, Chicago, IL, PEST 37.

Domir, S.C., and C.L. Foy.
1978a. A study of ethylene and CO$_2$ evolution from ethephon in tobacco. Pestic. Biochem. Physiol., 9:1-8.

Domir, S.C., and C.L. Foy.
1978b. Movement and metabolic fate of [^{14}C]ethephon in flue-cured tobacco. Pestic. Biochem. Physiol., 9:9-22.

Domir, S.C., E.A. Woolson, P.C. Kearney, and A.R. Isensee.
1976a. Translocation and metabolic fate of monosodium methanearsonic acid in wheat (*Triticum aestivum* L.). J. Agric. Food Chem., 24(6):1214-1217.

Domir, S.C., E.A. Woolson, P.C. Kearney, and A.R. Isensee.
1976b. Movement and metabolic fate of MSMA in wheat. Abstr. Weed Sci. Soc. Am., 76.

Donninger, C., B.T. Nobbs, and K. Wilson.
1971. An enzyme catalysing the hydrolysis of phosphoric acid diesters in rat liver. Biochem. J., 122:51P.

Donoho, A., J. Manthey, J. Occolowitz, and L. Zornes.
1978. Metabolism of monensin in the steer and rat. J. Agric. Food Chem., 26(5):1090-1095.

Dorn, S., G. Oesterhelt, M. Suchy, K.H. Trautmann, and H.-K. Wipf.
1976. Environmental degradation of the insect growth regulator 6,7-epoxy-1-(*p*-ethylphenoxy)-3-ethyl-7-methylnonane (Ro 10-3108) in polluted water. J. Agric. Food Chem., 24(3):637-640.

Dorough, H.W., R.A. Cardona, and S.C. Lolmaugh.
1974. Metabolism of the herbicide methazole [2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazoline-3,5-dione] in rats. Drug. Metab. Dispos., 2(2):129-139.

Dorough, H.W., K. Huhtanen, T.C. Marshall, and H.E. Bryant.
1978. Fate of endosulfan in rats and toxicological considerations of apolar metabolites. Pestic. Biochem. Physiol., 8:241-252.

Dorough, H.W., and D.E. Nye.
1976. Metabolism of croneton (2-ethylthio-methylphenyl *N*-methylcarbamate) in large animals. Abstr 172nd ACS Meeting, San Francisco, CA, PEST 93.

Dorough, H.W., and D.M. Whitacre.
1977. Persistence and metabolism of ^{14}C-leptophos in burley tobacco. J. Econ. Entomol., 70(2):153-155.

Douch, P.G.C., and H.M. Gahagan.
1977. The metabolism of niclosamide and related compounds by *Moniezia expansa*, *Ascaris lumbricoides* var. *suum*, and mouse- and sheep-liver enzymes. Xenobiotica, 7(5):301-307.

Douch, P.G.C., C.E.R. Hook, and J.N. Smith.
1968. Metabolism of folithion (dimethyl 4-nitro-3-methylphenyl phosphorothionate). Australasian J. Pharm., 49(584)(Suppl. 66): 570-571.

Drager, G.
1978. Studies on the isolation and identification of extractable and nonextractable metabolites of the insecticide carbamate croneton. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-23.

Draper, W.M., and D.G. Crosby.
1978. Pesticide photodecompositions in dilute hydrogen peroxide solution. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 52.

Duhm, B., W. Maul, H. Medenwald, K. Patzschke, and L.-A. Wegner.
1961. Radioaktiv untersuchungen mit einem neuen molluscicid. Z. Naturforsch., 16b:509-515.

Dunn, J.S., N.H. Booth, P.B. Bush, R.L. Farrell, D. Thomason, and D.D. Goetsch.
1978. The accumulation and elimination of tissue residues after feeding pentachloronitrobenzene to white leghorn cockerels. Poultry Sci., 57(6):1533-1538.

Duseja, D.R., and E.E. Holmes.
1978. Field persistence and movement of trifluralin in two soil types. Soil Sci., 125(1):41-48.

Dutton, A.J., T.R. Roberts, and A.N. Wright.
1976. Characterization of acidic conjugates of flamprop in wheat. Chemosphere, 5(3):195-200.

Duwel, D.
1977. Fenbendazole. II. Biological properties and activity. Pestic. Sci., 8:550-555.

Eaton, B.J., J.D. Magnussen, and D.P. Rainey.
1976. Metabolism of tebuthiuron in soil and plants. Abstr. Weed Sci. Soc. Amer., 83.

Eberspacher, J., S. Haug, F. Blobel, and K. Sauber.
1976. Breakdown of the herbicide pyramin by micro-organisms of the soil. Zbl. Bakt. Hyg., I. Abt. Orig., B 162:145-148.

Edelson, J., and J.P. McMullen.
1976. Hexachlorophene metabolism in rats: The hepatic route. Arch. Internat. Pharmacodynam. Therapie, 220(1):140-147.

Edmonds, J.S., and K.A. Francesconi.
1977. Methylated arsenic from marine fauna. Nature, 265(5593):436.

Edmonds, J.S., K.A. Francesconi, J.R. Cannon, C.L. Raston, B.W. Skelton, and A.H. White.
1977. Isolation, crystal structure and synthesis of arsenobetaine, the arsenical constituent of the western rock lobster *Panulirus longipes cygnus* George. Tetrahedron Lett., 18:1543-1546.

Edwards, J.P., and D.G. Rowlands.
1977. Metabolism of a synthetic insect juvenile hormone (JH-1) during the development of *Tribolium castaneum* (Herbst) (Coleoptera, Tenebrionidae). Pestic. Biochem. Physiol., 7:194-201.

Edwards, J.P., and D.G. Rowlands.
1978. Metabolism of a synthetic juvenile hormone (JH-I) in two strains of the grain weevil, *Sitophilus granarius*. Insect Biochem., 8:23-28.

Egyankor, K.B., and C.S. Franklin.
1977. Interaction of the trichlorobenzenes with cytochrome *P*-450. Biochem. Soc. Trans., 5(5):1519-1520.

Ehmann, J.L.
1976. A model system: The photochemical interaction of heptachlor and selected epicuticular wax components of the tomato fruit and pear leaf. Dissert. Abstr., 37B(2):597-598.

El Beit, I.O.D., J.V. Wheelock, and D.E. Cotton.
1977. Factors affecting the fate of dimethoate in soils. Intern. J. Environ. Studies, 11:113-124.

El Beit, I.O.D., J.V. Wheelock, and D.E. Cotton.
1978a. Factors influencing the degradation of dimethoate in soils and solutions. Intern. J. Environ. Studies, 11:253-260.

El Beit, I.O.D., J.V. Wheelock, and D.E. Cotton.
1978b. Separation and characterization of dimethoate metabolites developing in soil and alkaline solution. Intern. J. Environ. Studies, 12:215-225.

Elder, V.A., R.E. Green, and B.L. Koch.
1978. Degradation of ^{14}C-carbonyl and ^{14}C-ring-labeled diuron in two soils and availability of residues to oats. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 63.

El-Dib, M.A., and O.A. Aly.
1976a. Persistence of some phenylamide pesticides in the aquatic environment - I. Hydrolysis. Water Res., 10:1047-1050.

El-Dib, M.A., and O.A. Aly.
1976b. Persistence of some phenylamide pesticides in the aquatic environment - II. Adsorption on clay minerals. Water Res., 10: 1051-1053.

El-Dib, M.A., and O.A. Aly.
1976c. Persistence of some phenylamide pesticides in the aquatic environment - III. Biological degradation. Water Res., 10:1055-1059.

Elgar, K.E.
1974. The dissipation and accumulation of aldrin and dieldrin residues in soil. Environ. Qual. Safety, 3(Suppl.):250-257.

Elliott, M., N.F. Janes, D.A. Pulman, L.C. Gaughan, T. Unai, and J.E. Casida.
1976. Radiosynthesis and metabolism in rats of the 1R isomers of the insecticide permethrin. J. Agric. Food Chem., 24(2):270-276.

Elmamlouk, T.H., and T. Gessner.
1976. Species difference in metabolism of parathion: Apparent inability of hepatopancreas fractions to produce paraoxon. Comp. Biochem. Physiol., 53C:19-24.

Elo, H.
1976. Distribution and elimination of 2-methyl-4-chlorophenoxyacetic acid (MCPA) in male rats. Acta Pharmacol. Toxicol., 39(1):58-64.

El-Oshar, M., and W.C. Dauterman.
1977. Studies on the metabolism of formothion. Chemosphere, 9: 531-536 (repeated in 10:611-616).

El Zorgani, G.A.
1975. Residues of DDT in cottonseed after spraying with DDT and torbidan. Pestic, Sci., 6:457-460.

El Zorgani, G.A.
1976. Persistence of organochlorine insecticides in the field in the Gezira soil under cotton. Bull. Environ. Contam. Toxicol., 15(3):378-382.

Emmerling, O.
1896. Zur frage, wodurch die giftigkeit arsenhaltiger tapeten bewirkt wird. Chem. Ber. (Berlin), 29:2728.

Engelhardt, G., and P. Wallnofer.
1976a. Effect of 2-methyl- and 2-halogen-substitution on the rate of hydrolysis of benzanilide fungicides by *Bacillus sphaericus*. Chemosphere, 5(2):91-94.

Engelhardt, G., and P. Wallnofer.
1976b. Hydrolysis of methoxysubstituted phenylureas, acylanilides, and phenylcarbamates by a microbial aryl acylamidase. Zbl. Bakt. Hyg., I. Abt. Orig., B 162:138-144.

Engelhardt, G., and P.R. Wallnofer.
1978. Microbial transformation of the triazinone herbicide metamitron to desaminometamitron. Chemosphere, 7(6):463-466.

Engst, R., R.M. Macholz, and M. Kujawa.
1976a. The metabolism of hexachlorobenzene (HCB) in rats. Bull. Environ. Contam. Toxicol., 16(2):248-252.

Engst, R., R.M. Macholz, und M. Kujawa.
1976b. Nachweis von metaboliten des hexachlorcyclohexan im menschlichen urin. Z. Ges. Hyg. Grenz., 22:205-208.

Engst, R., R.M. Macholz, und M. Kujawa.
1976c. Uber das vorkommen von β-glucuronidisch gebundenen metaboliten der hexachlorcyclohexan-isomere im menschlichen urin. Z. Ges. Hyg. Grenz., 22:495-498.

Engst, R., R.M. Macholz, and M. Kujawa.
1977. The metabolism of lindane in a culture of mould and the degradation scheme of lindane. Chemosphere, 6(7):401-418.

Engst, R., R.M. Macholz, and M. Kujawa.
1978. Metabolism of gamma-hexachlorocyclohexan (HCH) *in vivo*. Metabolism of orally administered gamma-2,3,4,5,6-pentachlorocyclohexen (PCCH). J. Environ. Sci. Hlth., 13B(4):425-427.

Engst, R., R.M. Macholz, M. Kujawa, H. Lewerenz, and R. Plass.
1976d. The metabolism of lindane and its metabolites Gamma-2,3,4,5,6-pentachlorocyclohexene, pentachlorobenzene, and pentachlorophenol in rats and the pathways of lindane metabolism. J. Environ. Sci. Hlth., B11(2):95-117.

Epstein, E., I. Klein, and S. Lavee.
1977. The fate of 1,2-^{14}C-(chloroethyl)phosphonic acid (ethephon) in olive (*Olea europea*). Physiol. Plant., 39:33-37.

Erley, D., S. Southard, and H. Emmerich.
1975. Excretion of juvenile hormone and its metabolites in the locust, *Locusta migratoria*. J. Insect Physiol., 21:61-70.

Erne, K.
1966a. Distribution and elimination of chlorinated phenoxyacetic acids in animals. Acta vet. scand., 7:240-256.

Erne, K.
1966b. Studies on the animal metabolism of phenoxyacetic herbicides. Acta vet. scand., 7:264-271.

Erne, K., and M. Nordkvist.
1970. The disappearance rate in reindeer of famphur, an organophosphorus parasiticide. Acta vet. scand., 11:209-218.

Ernst, W., H. Goerke, and K. Weber.
1977. Fate of ^{14}C-labelled di-, tri- and pentachlorobiphenyl in the marine annelid *Nereis virens* II. Degradation and faecal elimination. Chemosphere, 9:559-568.

Esaac, E.G., and F. Matsumura.
1977. A novel reductive system involving flavoprotein in the rat intestine. Abstr. 174th ACS Meeting, Chicago, IL, PEST 31.

Eshel, J., R.L. Zimdahl, and E.E. Schweizer.
1978. Uptake and translocation of ethofumesate in sugarbeet plants. Pestic. Sci., 9:301-304.

Estenik, J.F.
1978. Toxicity studies of insecticides with laboratory colonies of midge larvae, *Chironomus riparius* (=*Chironomus thummi*), and mosquito larvae, *Aedes aegypti*, and the *in vitro* characterization of aldrin epoxidation in the midge. Dissert. Abstr., 39B(4): 1615-1616.

Etges, F.J., E.J. Bell, and D.E. Gilbertson.
1965. Bacterial degradation of some molluscicidal chemicals. Amer. J. Trop. Med. Hyg., 14(5):846-851.

Eto, M., S. Okabe, Y. Ozoe, and K. Maekawa.
1977. Oxidative activation of *O,S*-dimethyl phosphoramidothiolate. Pestic. Biochem. Physiol., 7:367-377.

Fabacher, D.L., and H. Chambers.
1976. Uptake and storage of ^{14}C-labeled endrin by the livers and brains of pesticide-susceptible and resistant mosquitofish. Bull. Environ. Contam. Toxicol., 16(2):203-207.

Faiman, M.D., D.E. Dodd, and R.E. Hanzlik.
1978. Distribution of S^{35} disulfiram and metabolites in mice, and metabolism of S^{35} disulfiram in the dog. Res. Comm. Chem. Pathol. Pharmacol., 21(3):543-567.

Fanelli, R., C. Chiabrando, M. Salmona, S. Garattini, and P.G. Caldera.
1978. Degradation of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin in organic solvents by gamma ray irradiation. Experientia, 34(9): 1126-1127.

Fang, S.C., E. Fallin, and V.H. Freed.
1977. Maternal transfer of ^{14}C-*p,p*'-DDT *via* placenta and milk and its metabolism in infant rats. Arch. Environ. Contam. Toxicol., 5:427-436.

Fasco, M.J., P.P. Dymerski, J.D. Wos, and L.S. Kaminsky.
1978. A new warfarin metabolite: Structure and function. J. Med. Chem., 21(10):1054-1059.

Fedtke, C., and R.R. Schmidt.
1977. Chlorfenprop-methyl: Its hydrolysis *in vivo* and *in vitro* and a new principle for selective herbicidal action. Weed Res., 17:233-239.

Ferguson, J.A., and F. Korte.
1977. Epoxidation of aldrin to *exo*-dieldrin by soil bacteria. Appl. Environ. Microbiol., 34(1):7-13.

Feroz, M., and M.A.Q. Khan.
1977. Metabolism, tissue distribution and elimination of C-14-*cis*-chlordane in the tropical fish, *Cichlids*. Abstr. 174th ACS Meeting, Chicago, IL, PEST 30.

Feung, C.-S., R.H. Hamilton, and R.O. Mumma.
1976. Metabolism of 2,4-dichlorophenoxyacetic acid. 10. Identification of metabolites in rice root callus tissue cultures. J. Agric. Food Chem., 24(5):1013-1015.

Feung, C.S., S.L. Loerch, R.H. Hamilton, and R.O. Mumma.
1978. Comparative metabolic fate of 2,4-dichlorophenoxyacetic acid in plants and plant tissue culture. J. Agric. Food Chem., 26(5):1064-1067.

Fickle, J.S.
1974. Environmental factors affecting the movement and persistence of chloramben in soils. Dissert. Abstr., 34B(9):4160.

Filonow, A.B., L.W. Jacobs, and M.M. Mortland.
1976. Fate of polybrominated biphenyls (PBB's) in soils. Retention of hexabromobiphenyl in four Michigan soils. J. Agric. Food Chem., 24(6):1201-1204.

Finlayson, D.G., I.H. Williams, M.J. Brown, and C.J. Campbell.
1976a. Distribution of insecticide residues in carrots at harvest. J. Agric. Food Chem., 24(3):606-608.

Finlayson, D.G., I.H. Williams, M.J. Brown, and C.J. Campbell.
1976b. Translocation and persistence of topically applied diazinon and phorate in beans. Can. J. Plant Sci., 56:947-952.

Flashinski, S.J.
1974. Metabolism of dyfonate by soil fungi. Dissert. Abstr., 35(5):2239.

Fleeker, J.R., and H.M. Lacy.
1977. Photolysis of methyl 2-benzimidazolecarbamate. J. Agric. Food Chem., 25(1):51-55.

Fletcher, C.L., and D.D. Kaufman.
1975. Hydroxylation of monochloroaniline pesticide residues. Abstr. Weed Sci. Soc. Amer., 76.

Foerster, L.A.
1976. Unpublished results, Ph.D. thesis, University of London (1974). In: D.J. Galley and L.A. Foerster, Pestic. Sci., 7:549-552.

Foerster, L.A., and D.J. Galley.
1976. Movement of phorate and metabolites from treated leaflets to aphid colonies on broad bean plants. Pestic. Sci., 7:436-440.

Foster, T.S., and S.U. Khan.
1976. Metabolism of atrazine by the chicken. J. Agric. Food Chem., 24(3):566-570.

Foster, T.S., and J.G. Saha.
1978. The *in vitro* metabolism of lindane by an enzyme preparation from chicken liver. J. Environ. Sci. Hlth., B13(1):25-45.

Foy, C.L., E.R. Butts, and D.W. Jones.
1973. Enzymatic release of methazole-^{14}C and metabolites from methanol extracted cotton tissues and from a polar fraction of methanol shoot extracts. Abstr. Weed Sci. Soc. Amer., 62.

Francis, A.J., R.J. Spanggord G.I. Ouchi, and N. Bohonos.
1978. Cometabolism of DDT analogs by a *Pseudomonas* sp. Appl. Environ. Microbiol., 35(2):364-367.

Francis, A.J., R.J. Spanggord, G.I. Ouchi, R. Bramhall, and N. Bohonos.
1976. Metabolism of DDT analogues by a *Pseudomonas* sp. Appl. Environ. Microbiol., 32(2):213-216.

Franco, L., and A.M. Municio.
1975. Comparative metabolism of 3-amino-1,2,4-triazole. Gen. Pharmacol., 6:163-169.

Frank, A.
1971. Studies on the metabolism of 2-(2-furyl)benzimidazole in certain mammals. Acta Pharmacol. Toxicol., 29,Suppl 2: 7-124.

Frank, R., G.J. Sirons, N.J. Paik, and M. Valk.
1977. Fate of propachlor applied to onions and organic soils. Can. J. Plant Sci., 57:473-477.

Frear, D.S., and H.R. Swanson.
1975a. Metabolism of cisanilide (*cis*-2,5-dimethyl-1-pyrrolidinecarboxanilide) by excised leaves and cell suspension cultures of carrot and cotton. Pestic. Biochem. Physiol., 5:73-80.

Frear, D.S., and H.R. Swanson.
1975b. Oxidative metabolism of cisanilide (*cis*-2,5-dimethyl-1-pyrrolidinecarboxanilide) by rat liver microsomes. Abstr. 170th ACS Meeting, Chicago, IL, PEST 10.

Frear, D.S., and H.R. Swanson.
1976. Metabolism of cisanilide (*cis*-2,5-dimethyl-1-pyrrolidinecarboxanilide) by rat liver microsomes. Pestic. Biochem. Physiol., 6:52-57.

Frear, D.S., and H.R. Swanson.
1977. 1-*O*-(3-Amino-2,5-dichlorobenzoyl)-β-D-glucoside: A new chloramben metabolite in plants. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 41.

Frear, D.S., and H.R. Swanson.
1978. Behavior and fate of [^{14}C]maleic hydrazide in tobacco plants. J. Agric. Food Chem., 26(3):660-666.

Frear, D.S., H.R. Swanson, and K.L. Davison.
1975. Cisanilide (*cis*-2,5-dimethyl-1-pyrrolidinecarboxanilide) metabolism in plants: Isolation, characterization and degradation of insoluble residue fraction. Abstr. 170th ACS Meeting, Chicago, IL, PEST 11.

Frear, D.S., H.R. Swanson, E.R. Mansager, and R.G. Wien.
1978. Chloramben metabolism in plants: Isolation and identification of glucose ester. J. Agric. Food Chem., 26(6):1347-1351.

Freeman, H.P., A.W. Taylor, and W.M. Edwards.
1975. Heptachlor and dieldrin disappearance from a field soil measured by annual residue determinations. J. Agric. Food Chem., 23(6):1101-1105.

Friedman, A.R., K.T. Koshy, and A.L. VanDerSlik.
1974. The photolysis of benzoyl chloride (2,4,6-trichlorophenyl)hydrazone. Environ. Qual. Safety 3(Suppl.):298-301.

Friedman, O.M.
1967. Recent biologic and chemical studies of cyclophosphamide (NSC-26271). Cancer Chemothera., 51(6):327-333.

Friedman, O.M., S. Bien, and J.K. Chakrabarti.
1965. Studies on the hydrolysis of cyclophosphamide. I. Identification of *N*-(2-hydroxyethyl)-*N*'-(3-hydroxypropyl)ethylenediamine as the main product. J. Amer. Chem. Soc., 87(21):4978-4979.

Friedmann, E.
1911. Zur kenntnis des abbaues der carbonsauren im tierkorpe. XIV. Uber die hydrierung im tierkorpe. Biochem. Z., 35:49-56.

Fries, G.F., H.C. Cecil, J. Bitman, and R.J. Lillie.
1976. Retention and excretion of polybrominated biphenyls by hens. Bull. Environ. Contam. Toxicol., 15(3):278.

Fuchs, A., and F.W. de Vries.
1978a. Bacterial breakdown of benomyl. I. Pure cultures. A. van Leeuwenhoek, J. Microbiol. Serol., 44:283-292.

Fuchs, A., and F.W. de Vries.
1978b. Bacterial breakdown of benomyl. II. Mixed cultures A. van Leeuwenhoek, J. Microbiol. Serol., 44:293-309.

Fuchs, A., F.W. de Vries, and A.M.J. Aalbers.
1976a. Uptake, distribution and metabolic fate of ^{3}H-triforine in plants. I. Short-term experiments. Pestic. Sci., 7:115-126.

Fuchs, A., F.W. de Vries, and A.M.J. Aalbers.
1976b. Uptake, distribution and metabolic fate of ^{3}H-triforine in plants. II. Long-term experiments. Pestic. Sci., 7:127-134.

Fuchs, A., A.L. Homans, and F.W. de Vries.
1970. Systemic activity of benomyl against *Fusarium* wilt of pea and tomato plants. Phytopathologische Z., 69:330-343.

Fuchs, A., and W. Ost.
1976. Translocation, distribution and metabolism of triforine in plants. Arch. Environ. Contam. Toxicol., 4:30-43.

Fuchsbichler, G., A. Suss, und P. Wallnofer.
1978a. Aufnahme von 4-chlor- und 3,4-dichloranilin durch kulturpflanzen. (Uptake of 4-chloro- and 3,4-dichloroaniline by cultivated plants). J. Plant Dis. Protect., 85(5):298-307.

Fuchsbichler, G., A. Suss, and P. Wallnofer.
1978b. Degradation of 2-chloro, 3-chloro-, 4-chloro- 3,4-dichloroaniline and plant uptake of 4-chloroaniline in soil. J. Plant Dis. Protect., 85(12):724-734.

Fuhremann, T.W., and E.P. Lichtenstein.
1978. Release of soil-bound methyl $[^{14}C]$parathion residues and their uptake by earthworms and oat plants. J. Agric. Food Chem., 26(3):605-610.

Fujii, Y., F. Kurokawa, S. Ishida, I. Yamaguchi, and T. Misato.
1976. Metabolism of 3,3'-dimethyl-4-methoxybenzophenone (NK-049) in the rat. J. Pestic. Sci., 1:313-320.

Fujii, Y., T. Kurokawa, I. Yamaguchi, and T. Misato.
1978. Selective herbicidal activity of 3,3'-dimethyl-4-methoxybenzophenone (Methoxyphenone, NK-049); absorption, translocation and metabolism. J. Pestic. Sci., 3:291-298.

Fung, K.K.H.
1975. Determination and identification of *S*-methyl *N*-[(methylcarbamoyl)oxy]thioacetimidate (methomyl) residues in tobacco. J. Agric. Food Chem., 23(4):695-698.

Fung, K.K.H., and N.C. Uren.
1977. Microbial transformation of *S*-methyl *N*-[(methylcarbamoyl)oxy]thioacetimidate (methomyl) in soils. J. Agric. Food Chem., 25(4):966-969.

Furukawa, K., and F. Matsumura.
1976. Microbial metabolism of polychlorinated biphenyls. Studies on the relative degradability of polychlorinated biphenyl components by *Alkalignes* sp. J. Agric. Food Chem., 24(2):251-256.

Furukawa, K., F. Matsumura, and K. Tonomura.
1978a. *Alcaligenes* and *Acinetobacter* strains capable of degrading polychlorinated biphenyls. Agric. Biol. Chem., 42(3):543-548.

Furukawa, K., K. Tonomura, and A. Kamibayashi.
1978b. Effect of chlorine substitution on the biodegradability of polychlorinated biphenyls. Appl. Environ. Microbiol., 35(2): 223-227.

Fykse, H.
1976. Untersuchungen uber *Sonchus arvensis* L. III. Metabolismus von MCPA. Weed Res., 16:309-316.

Gab, S., W.P. Cochrane, H. Parlar, and F. Korte.
1975. Photochemische reaktionen von chlorden-isomeren des technischen chlordans. Z. Naturforsch., 30b:239-244.

Gab, S., S. Nitz, H. Parlar, and F. Korte.
1976. Ozonolysis of 2,3,3a,4,5,8-hexachloro-3a,6,7,7a-tetrahydro-1,6-methano-1H-indene: Isolation of a stable ozonide having a 3,5-dichloro-1,2,4-trioxolane structure. Angew. Chem. Int. Ed. Engl., 15(7):433.

Gaffney, P.E.
1977. Chlorobiphenyls and PCB's: Formation during chlorination. J. Water Pollut. Cont. Fed., 49(3):401-404.

Gage, J.C.
1975. Mechanisms for the biodegradation of organic mercury compounds: The actions of ascorbate and of soluble proteins. Toxicol. Appl. Pharmacol., 32(2):225-238.

Gaillardon, P., R. Calvet, and M. Terce.
1977. Adsorption et desorption de la terbutryne par une montmorillonite-Ca et des acides humiques seuls ou en melanges. Weed Res., 17:41-48.

Galley, D.J., and L.A. Foerster.
1976a. Distribution and loss of phorate residues in the foliage of broad bean plants following root uptake of ^{14}C-labelled phorate. Pestic. Sci., 7:301-306.

Galley, D.J., and L.A. Foerster.
1976b. Phorate residues in aphid colonies on broad bean plants in relation to the site of application. Pestic. Sci., 7:549-552.

Gallo, M.A., E. Buchmann, and L. Golberg.
1976. Mitochondrial effects of 2,6-dichloro-4-nitroaniline and its metabolites. Toxicol. Appl. Pharmacol., 35:51-61.

Gallon, J.R., M.I. Ul-Haque, and A.E. Chaplin.
1978. Fluoroacetate metabolism in *Gloeocapsa* sp. LB795 and its relationship to acetylene reduction (nitrogen fixation). J. Gen. Microbiol., 106:329-336.

Gandolfi, A.J.
1973. Hexachlorophene: Its absorption, distribution, excretion, and biotransformation in the rat and rabbit and *in vitro* interaction with rat liver microsomes. Dissert. Abstr., 33B(9):4106.

Gandolfi, A.J., and D.R. Buhler.
1974. Biliary metabolites and enterohepatic circulation of hexachlorophene in the rat. Xenobiotica, 4(11):693-704.

Gandolfi, A.J., and D.R. Buhler.
1977. Metabolism of hexachlorophene in the rabbit. Excretion, tissue distribution, and characterization of the urinary glucuronide conjugate. J. Agric. Food Chem., 25(1):21-25.

Gandolfi, A.J., F.N. Dost, and D.R. Buhler.
1972. Absorption, excretion and metabolism of hexachlorophene in the rat and rabbit. Fed. Proc., 31:605.

Gardiner, J.A., R.K. Brantley, and H. Sherman.
1968. Isolation and identification of a metabolite of methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate in rat urine. J. Agric. Food Chem., 16(6):1050-1052.

Gardner, A.M., H.F. Righter, and J.A.G. Roach.
1976. Excretion of hydroxylated polychlorinated biphenyl metabolites in cows' milk. J. Assoc. Off. Anal. Chem., 59(2):273-277.

Gasztonyi, M., and Gy. Josepovits.
1978. Translocation and metabolism of triadimefon in different plant species. Acta Phytopathol. Acad. Scient. Hung., 13(3-4): 403-415.

Gaughan, L.C., M.E. Ackerman, T. Unai, and J.E. Casida.
1978a. Distribution and metabolism of *trans*- and *cis*-permethrin in lactating Jersey cows. J. Agric. Food Chem., 26(3):613-618.

Gaughan, L.C., and J.E. Casida.
1978. Degradation of trans- and cis-permethrin on cotton and bean plants. J. Agric. Food Chem., 26(3):525-528.

Gaughan, L.C., R.A. Robinson, and J.E. Casida.
1978b. Distribution and metabolic fate of trans- and cis-permethrin in laying hens. J. Agric. Food Chem., 26(6):1374-1380.

Gaughan, L.C., T. Unai, and J.E. Casida.
1976. Comparative permethrin metabolism: Rat and cow, bean and cotton. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 36.

Gaughan, L.C., F. Unai, and J.E. Casida.
1977. Permethrin metabolism in rats. J. Agric. Food Chem., 25(1):9-17.

Gebefugi, I., R. Baumann, and F. Korte.
1977. Photochemischer abbau von 2,3,7,8-tetrachlordibenzo-p-dioxin (TCDD) unter simulierten umweltbedingungen. Naturwissen., 64:486.

Gerayesh-Nejad, S., R.S. Jones, and D.V. Parke.
1975. Comparison of rat hepatic microsomal mixed-function oxidase activities in microsomal preparations, isolated hepatocytes and liver slices. Biochem. Soc. Trans., 3:403-405.

Gerstl, Z., U. Mingelgrin, and B. Yaron.
1977. Behavior of vapam and methylisothiocyanate in soils. Soil Sci. Soc. Amer. J., 41:545-548.

Gerstl, Z., and B. Yaron.
1978. Adsorption and desorption of parathion by attapulgite as affected by the mineral structure. J. Agric. Food Chem., 26(3):569-573.

Getzin, L.W.
1977. Persistence of the insecticide, Akton, in soil. Bull. Environ. Contam. Toxicol., 18(4):499-502.

Getzin, L.W., and I. Rosefield.
1971. Partial purification and properties of a soil enzyme that degrades the insecticide malathion. Biochim. Biophys. Acta, 235:442-453.

Getzin, L.W., and J.L. Saunders.
1977. Translocation, distribution, and metabolism of phorate in Douglas-fir. Forest Sci., 23(3):355-360.

Ghiasuddin, S.M., and R.E. Menzer.
1976. Microsomal epoxidation of aldrin to dieldrin in rats. Bull. Environ. Contam. Toxicol., 15(3):324-329.

Ghiasuddin, S.M., R.E. Menzer, and J.O. Nelson.
1976. Metabolism of 2,5,2'-trichloro-, 2,5,2',5'-tetrachloro-, and 2,4,5,2',5'-pentachlorobiphenyl in rat hepatic microsomal systems. Toxicol. Appl. Pharmacol., 36:187-194.

Giardina, M.C., and R. Buffone.
1977. Pathway of initial prometryn degradation by a soil bacteria. Chemosphere, 9:589-594.

Giblin, F.J., and E.J. Massaro.
1975. The erythrocyte transport and transfer of methyl-mercury to the tissues of the rainbow trout (*Salmo gairdneri*). Toxicol., 5:243-254.

Giblin, F.J., and E.J. Massaro.
1977. The uptake of methylmercury and methylmercury cysteine by the rainbow trout (*Salmo gairdneri*) kidney. Gen Pharmac., 8:103-107.

Gibson, W.P., and R.G. Burns.
1977. The breakdown of malathion in soil and soil components. Microbial Ecol., 3:219-230.

Gilbert, E.E., and J.J. Donleavy.
1938. The polycondensation of acrolein. J. Amer. Chem. Soc., 60:1911-1914.

Gilbert, M.
1976. Fate of chlorothalonil in apple foliage and fruit. J. Agric. Food Chem., 24(5):1004-1007.

Gilbert, M., and D.J. Lisk.
1978. Residues of dacthal herbicide in carrots. Bull. Environ. Contam. Toxicol., 20:180-183.

Gill, S.S., B.D. Hammock, and J.E. Casida.
1974. Mammalian metabolism and environmental degradation of the juvenoid 1-(4'-ethylphenoxy)-3,7-dimethyl-6,7-epoxy-*trans*-2-octene and related compounds. J. Agric. Food Chem., 22(3):386-395.

Gingell, R.
1976. Metabolism of ^{14}C-DDT in the mouse and hamster. Xenobiotica, 6(1):15-20.

Gingerich, L.L., and R.J. Zimdahl.
1976. Soil persistence of isopropalin and oryzalin. Weed Sci., 24:431-434.

Glickman, A.H., C.N. Statham, A. Wu, and J.J. Lech.
1977. Studies on the uptake, metabolism and disposition of pentachlorophenol and pentachloroanisole in rainbow trout. Toxicol. Appl. Pharmacol., 41:649-658.

Goerke, H., and W. Ernst.
1977. Fate of ^{14}C-labelled di-, tri-, and pentachlorobiphenyl in the marine annelid *Nereis virens* I. Accumulation and elimination after oral administration. Chemosphere, 6:551-558.

Goettfert, J., H. Parlar, and F. Korte.
1978. Microbial transformation of [^{14}C]methabenzthiazuron by the soil fungus *Hypocrea* Cf. *pilulifera* Webster St. Con: Isolation, identification, and characterization of some metabolites from the chloroform extract. J. Agric. Food Chem., 26(3):628-632.

Golab, T., W.A. Althaus, and H.L. Wooten.
1978. Degradation of trifluralin in soil. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-505.

Golab, T., C.E. Bishop, A.L. Donoho, J.A. Manthey, and L.L. Zornes.
1975. Behavior of ^{14}C-oryzalin in soil and plants. Pestic. Biochem. Physiol., 5:196-204.

Golovleva, L.A., A.M. Zyakun, and G.K. Skryabin.
1978. Cometabolism of DDT and ordram. Abstr. 4th Internat. Congr. Pest. (IUPAC), Zurich, V-610.

Gorbach, S.G., K. Kuenzler, and J. Asshauer.
1977. On the metabolism of Hoe 23408 OH in wheat. J. Agric. Food Chem., 25(3):507-511.

Gorbach, S., W. Thier, H.M. Kellner, E.F. Schulze, K. Kuenzler, and H. Fischer.
1974. Environmental impact of pyrazophos. 1. Contribution, degradation in plants and in the rat. Environ. Qual. Safety, 3(Suppl.):840-844.

Gosio, B.
1892. Action de quelques moisissures sur les composes fixes d'arsenic. Arch. Ital. Biolog., 18:253-265.

Gosio, B.
1897. Zur frage, wodurch die giftigkeit arsenhaltiger tapeten bedingt wird. Chem. Ber. (Berlin), 30:1024-1026.

Gosio, B.
1901. Recherches ulterieures sur la biologie et sur le chimisme des arsenio-moisissures. Arch. Ital. Biol., 35:201-213.

Gottrup, O., P.A. O'Sullivan, R.J. Schraa, and W.H. Vanden Born.
1976. Uptake, translocation, metabolism and selectivity of glyphosate in Canada thistle and leafy spurge. Weed Res., 16:197-201.

Goulding, R.L.
1973. Biodegradation of 2,4-D manufacturing wastes. Abstr. Weed Sci. Soc. Amer., 56.

Gowda, T.K.S., and N. Sethunathan.
1976. Persistence of endrin in Indian rice soils under flooded conditions. J. Agric. Food Chem., 24(4):750-753.

Gowda, T.K.S., and N. Sethunathan.
1977. Endrin decomposition in soils as influenced by aerobic and anaerobic conditions. Soil Sci., 124(1):5-9.

Gray, H.E.
1968. Plictran miticide--New approach to mite control. Down to Earth, 23(4):3-5.

Grayson, B.T., and S. Stokes.
1978. Hydrolysis of the wild oat herbicides flamprop-methyl, flamprop-ethyl, flamprop-isopropyl and benzoylprop-ethyl. Pestic. Sci., 9:595-602.

Greenhalgh, R., and W.D. Marshall.
1976. Ultraviolet irradiation of fenitrothion and the synthesis of the photolytic oxidation products. J. Agric. Food Chem., 24(4): 708-713.

Greenhalgh, R., G.W. Wood, and P.A. Pearce.
1977. A rapid GC method of monitoring mesurol [4-(methylthio)-3,5-xylyl-*N*-methyl carbamate] and its sulfoxide and sulfone metabolites and their persistence in lowbush blueberries. J. Environ. Sci. Hlth., B12(4):229-244.

Greenwood, D.R., and G.B. Russell.
1978. 26-Hydroxy-β-ecdysone, a metabolite of β-ecdysone in the blowfly, *Calliphora erythrocephala*. Experientia, 34(6):687-688.

Greenwood, M.R., T.W. Clarkson, R.A. Doherty, A.H. Gates, L. Amin-Zaki, S. Elhassani, and M.A. Majeed.
1978. Blood clearance half-times in lactating and nonlactating members of a population exposed to methylmercury. Environ. Res., 16:48-54.

Greer, G.L., and U. Paim.
1968. Degradation of DDT in Atlantic salmon (*Salmo salar*). J. Fish. Res. Bd. Canada, 25(11):2321-2326.

Gresshoff, P.M., H.K. Mahanty, and E. Gartner.
1977. Fate of polychlorinated biphenyl (Aroclor 1242) in an experimental study and its significance to the natural environment. Bull. Environ. Contam. Toxicol., 17(6):686-691.

Griffin, T.S.
1976. The dissipation of USB 3153 in soil. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 52.

Griffin, T.S.
1977. Soil bound residues from the degradation of USB 3153. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 39.

Grossman, F., H. Buchenauer, and L.V. Edgington.
1973. Photochemical transformation of some systemic fungicides. Abstr. 2nd Internat. Congr. Plant Pathol., No. 1015.

Grover, R.
1977. Mobility of dicamba, picloram and 2,4-D in soil columns. Weed Sci., 25(2):159-162.

Grudzinski, S., and H. Gniadek.
1977. O kondensacji 2,4-dwuchloro-6-metoksytriazynyn-1,3,5-(DCMT) z aminami i aminokwasami. Acta Polon. Pharm., 34(3): 285-293.

Grunicke, H., M. Liersch, H. Holzer, und H. Arnold.
1965. Untersuchungen zum wirkungsmechanismus von endoxan. Biochem. Pharmacol., 14:1485-1490.

Grunow, W., H.-J. Altmann, and Chr. Bohme.
1975. Uber den stoffwechsel von 3-amino-1,2,4-triazol in ratten. Arch. Toxicol., 34:315-324.

Grunow, W., H.-J. Altmann, und Chr. Bohme.
1978. Metabolisierung von buturon in der ratte. Food Cosmet. Toxicol., 16:349-353.

Grunow, W., und Chr. Bohme.
1974. Uber den stoffwechsel von 2.4.5-T und 2.4-D bei ratten und mausen. Arch. Toxicol., 32:217-225.

Guardigli, A., M.S. Lefar, M.A. Gallo, M. Laurent, and M. Buys.
1976. Residue uptake and depletion measurements of dietary oxadiazon in mammalian and avian species. Arch. Environ. Contam. Toxicol., 4(2):145-154.

Guarino, A.M., M.O. James, and J.R. Bend.
1977. Fate and distribution of the herbicides 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) in the dogfish shark. Xenobiotica, 7(10):623-631.

Guenzi, W.D., and W.E. Beard.
1976a. Picloram degradation in soils as influenced by soil water content and temperature. J. Environ. Qual., 5(2):189-192.

Guenzi, W.D., and W.E. Beard.
1976b. The effects of temperature and soil water on conversion of DDT to DDE in soil. J. Environ. Qual., 5(3):243-246.

Guenzi, W.D., and W.E. Beard.
1976c. DDT degradation in flooded soil as related to temperature. J. Environ. Qual., 5(4):391-394.

Guilbert, C.C., and A.E. Chung.
1974. Metabolism of cyclopropanecarboxylic acid. J. Biol. Chem., 249(4):1026-1030.

Guiney, P.D., and R.E. Peterson.
1978. Disposition of a polychlorinated biphenyl, 2,5,2',5'-tetrachlorobiphenyl, during sexual maturation and early development in rainbow trout. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 58.

Guiney, P.D., R.E. Peterson, M.J. Melancon, Jr., and J.J. Lech.
1977. The distribution and elimination of 2,5,2',5'-[^{14}C]tetrachlorobiphenyl in rainbow trout (*Salmo gairdneri*). Toxicol. Appl. Pharmacol., 39:329-338.

Guirguis, G.N.
1975. Carbaryl penetration and metabolism in the alfalfa leafcutting bee, *Megachile pacifica* (Panzer). Dissert. Abstr., 36(1): 81.

Gupta, P.K., and B.S. Paul.
1976. Bioavailability and metabolism of [^{32}P]malathion in the hen. Environ. Res., 12:334-339.

Gupta, P.K., and B.S. Paul.
1977. Biological fate of ^{32}P malathion in *Gallus domesticus* (Desi poultry birds). Toxicology, 7:169-177.

Gupta, P.K., B.S. Paul, and M. Ehrnebo.
1977. Absorption and elimination kinetics of ^{32}P malathion in the hen. Acta Pharmacol. Toxicol., 40:65-69.

Gutenmann, W.H., and D.J. Lisk.
1975. Tissue storage and excretion in milk of polybrominated biphenyls in ruminants. J. Agric. Food Chem., 23(5):1005-1007.

Guzik, F.F.
1978. Photolysis of isopropyl 3-chlorocarbanilate in water. J. Agric. Food Chem., 26(1):53-55.

Hafner, V.M.
1976. Uber den abbau von quintozen in gemusekulturen und gartnerisch genutzten erden (Teil 1). Anz. Schadlingskde., Pflanzen., Umwelt., 49:177-183.

Hafner, V.W.
1978. Pentachlornitrobenzol-, pentachloranilin- und methylthiopentachlorbenzol-ruckstande bei gemusekulturen und in gartnerisch genutzten erden. Anz. Schadlingskde., Pflanzen., Umwelt., 51:49-57.

Hallett, D.J., R. Greenhalgh, P. Weinberger, and R. Prasad.
1975. The absorption of fenitrothion during germination of stratified and nonstratified white pine seeds and identification of metabolites formed. Can. J. For. Res., 5:84-89.

Hallett, D.J., R. Greenhalgh, P. Weinberger, and R. Prasad.
1977. The uptake and metabolism of fenitrothion by germinating white pine, white spruce and yellow birch seeds. J. Environ. Sci. Hlth., B12(1):53-69.

Hallett, D.J., K.S. Khera, D.R. Stoltz, I. Chu, D.C. Villeneuve, and G. Trivett.
1978. Photomirex: Synthesis and assessment of acute toxicity, tissue distribution, and mutagenicity. J. Agric. Food Chem., 26(2):388-391.

Hamdi, Y.A., M.K. Zahran, and M.S. Tewfik.
1969. The breakdown of trifluralin by soil micro-organisms. PANS, 15(4):589-592.

Hammock, B.D., S.S. Gill, and J.E. Casida.
1974. Insect metabolism of a phenyl epoxygeranyl ether juvenoid and related compounds. Pestic. Biochem. Physiol., 4:393-406.

Hammock, B.D., S.S. Gill, L. Hammock, and J.E. Casida.
1975. Metabolic O-dealkylation of 1-(4'-ethylphenoxy)-3,7-dimethyl-7-methoxy or ethoxy-*trans*-2-octene, potent juvenoids. Pestic. Biochem. Physiol., 5:12-18.

Hammock, B.D., and S.M. Mumby.
1978. Inhibition of epoxidation of methyl farnesoate to juvenile hormone III by cockroach corpus allatum homogenates. Pestic. Biochem. Physiol., 9:39-47.

Hammock, B., J. Nowock, W. Goodman, V. Stamoudis, and L.I. Gilbert.
1975. The influence of hemolymph-binding protein on juvenile hormone stability and distribution in *Manduca sexta* fat body and imaginal discs *in vitro*. Molecular Cell. Endocrinol., 3:167-184.

Hansen, L.G., S.B. Dorn, S.M. Sundlof, and R.S. Vogel.
1978. Toxicity, accumulation, and depletion of hexachlorobenzene in laying chickens. J. Agric. Food Chem., 26(6):1369-1374.

Haque, A., I. Scheunert, and F. Korte.
1978a. Contributions to ecological chemistry CXL. Isolation and identification of a metabolite of pentachlorophenol-^{14}C in rice plants. Chemosphere, 1:65-69.

Haque, A., I. Schuphan, and W. Ebing.
1978b. Metabolic fate of a conjugated phenylurea-β-glucoside in plants. Abstr. 4th Internat. Congr. Pestic. Chem. (IUPAC), Zurich, V-513.

Haque, A., I. Weisgerber, and W. Klein.
1976a. Beitrage zur Okologischen Chemie CXXV. Buturon-^{14}C bound residue complex in wheat plants. Chemosphere, 5(3):167-172.

Haque, A., I. Weisgerber, and W. Klein.
1977a. Absorption, efflux, and metabolism of the herbicide [^{14}C] buturon as affected by plant nutrition. J. Exp. Bot., 28(103): 468-479.

Haque, A., I. Weisgerber, D. Kotzias, and W. Klein.
1977b. Conversion of [^{14}C]buturon in soil and leaching water under outdoor conditions. Pestic. Biochem. Physiol., 7:321-331.

Haque, A., I. Weisgerber, D. Kotzias, W. Klein, and F. Korte.
1976b. Contributions to ecological chemistry. CXII. Balance of conversion of buturon-^{14}C in wheat under outdoor conditions. J. Environ. Sci. Hlth., B11(3):211-223.

Haque, R., and D.R. Buhler.
1972. A proton magnetic resonance study of the interaction of hexachlorophene with amides and polypeptides. J. Amer. Chem. Soc., 94(6):1824-1828.

Haque, R., and J.T. Deagen.
1975. Binding of the chlorinated hydrocarbon bis(*p*-chlorophenyl) acetic acid with the enzyme carbonic anhydrase. Bull. Environ. Contam. Toxicol., 14(1):43-46.

Haque, R., J. Deagen, F.J. Biros, and R.T. Ross.
1976c. Binding of bis(*p*-chlorophenyl) acetic acid with bovine serum albumin. Pestic. Biochem. Physiol., 6:170-174.

Haque, R., J. Deagen, and D. Schmedding.
1975. Binding of 2,4-dichloro- and 2,4,5-trichlorophenoxyacetic acids to bovine serum albumin. A proton magnetic resonance study. J. Agric. Food Chem., 23(4):763-766.

Harding, G.C.H., and W.P. Vass.
1977. Uptake from sea water and clearance of ^{14}C-*p*,*p*'-DDT by the marine copepod *Calanus finmarchicus*. J. Fish. Res. Bd. Canada, 34(2):177-182.

Harger, T.R.
1976. Soil dissipation of dicamba and VEL-4207. Dissert. Abstr., 36(9):4253-4254.

Harger, T.R., and C.E. Rieck.
1976. Soil dissipation of dicamba and VEL-4207. Abstr. Weed Sci. Soc. Amer., 88-89.

Harke, H.-P., D. Schuller, und C.J. Drews.
1973. Pyrolyse von maleinsaurehydrazid und hydrazin. Z. Lebensm. Unters.-Forsch., 153:163-169.

Harned, W.H., and J.E. Casida.
1976. Dioxathion metabolites, photoproducts, and oxidative degradation products. J. Agric. Food Chem., 24(4):689-699.

Harris, C.R., and W.W. Sans.
1975. Persistence of Velsicol HCS-3260 (AG-chlordane) in mineral and organic soil. Proc. Entomol. Soc. Ontario, 106:34-38.

Hart, G.J., and R.D. O'Brien.
1976. Dissociation and phosphorylation constants for the inhibition of acetylcholinesterase by a series of novel *O*-ethyl *O*-phenyl *S*-*n*-propyl phosphorothioates. Pestic. Biochem. Physiol., 6:85-90.

Harvey, J., Jr.
1974. Metabolism of aldicarb and methomyl. Environ. Qual. Safety, 3(Suppl.):389-393.

Harvey, J., Jr.
1976a. Metabolism of ^{14}C-oxamyl in the peanut plant. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 55.

Harvey, J., Jr.
1976b. Decomposition of ^{14}C-oxamyl in soils and water. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 54.

Harvey, J., Jr., and I.J. Belasco.
1978. Metabolism of ^{14}C-oxamyl in the ruminant. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 53.

Harvey, J., Jr., and J.C.-Y. Han.
1977. Metabolism of oxamyl and its principal plant metabolites in the rat. Abstr. 174th ACS Meeting, Chicago, IL, PEST 27.

Harvey, J., Jr., and J.C.-Y. Han.
1978a. Metabolism of oxamyl and selected metabolites in the rat. J. Agric. Food Chem., 26(4):902-910.

Harvey, J., Jr., and J.C.-Y. Han.
1978b. Decomposition of oxamyl in soil and water. J. Agric. Food Chem., 26(3):536-541.

Harvey, J., Jr., J.C.-Y. Han, and R.W. Reiser.
1978. Metabolism of oxamyl in plants. J. Agric. Food Chem., 26(3):529-536.

Hasegawa, S., M. Tamari, and M. Kametaka.
1973. Incorporation of ciliatine (2-aminoethylphosphonic acid) into rat visceral organs and tissues. Nippon Nogeikagaku Kaishi, 47(11):673-680.

Hasegawa, S., M. Tamari, and M. Kametaka.
1975. The incorporation of ciliatine (2-aminoethylphosphonic acid) into rat liver lipids. J. Agric. Chem. Soc. Japan, 49(10):539-544.

Hasegawa, S., M. Tamari, and M. Kametaka.
1976. The distribution of ciliatine (2-aminoethylphosphonic acid) in bovine liver. Agr. Biol. Chem., 40(10):2097-2098.

Hass, J.R., L.T. Jao, N.K. Wilson, and H.B. Matthews.
1977. Metabolism of 4-chlorobiphenyl and 4,4'-dichlorobiphenyl in the rat: Qualitative and quantitative aspects. J. Agric. Food Chem., 25(6):1330-1333.

Hassall, K.A., A. Dionyssiou-Asteriou, and D. Manning.
1978. Metabolism of methylated analogs of aldrin and dieldrin by liver preparations from male and female rat. Pestic. Biochem. Physiol., 8:287-301.

Hassan, A., F.M. Abdel-Hamid, and S.I. Mohammed.
1977. Metabolism of ^{14}C-leptophos in the rat. Arch. Environ. Contam. Toxicol., 6:447-454.

Hawkins, D.R., W.H. Down, L.F. Chasseaud, and J.D. Lewis.
1974. The metabolic fate of tridemorph in rats. Pestic. Sci., 5: 535-542.

Hawkins, D.R., K.T. Weston, L.F. Chasseaud, and E.R. Franklin.
1977. Fate of methoprene (isopropyl (2*E*,4*E*)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate) in rats. J. Agric. Food Chem., 25(2):398-403.

Hawxby, K., and E. Basler.
1976. Effects of temperature on absorption and translocation of profluralin and dinitramine. Weed Sci., 24(6):545-548.

Hayashi, A., T. Saito, and K. Iyatomi.
1968. Studies on the increment of the efficacy of insecticides (VIII). Metabolism of ^{3}H-pyrethroids in the adult house fly, *Musca domestica vicina* Macq. Botyu-Kagaku, 33:90-95.

Heenan, M.P., and J.N. Smith.
1967. Conjugation of 1-naphthol and *p*-nitrophenol in flies: Formation of glucoside-6-phosphates. Life Sci., 6:1753-1757.

Helleberg, A., and N. Gyrd-Hansen.
1976. Mercury binding in the kidney of rats exposed to methoxyethyl mercury. Acta Pharmacol. Toxicol., 38:284-288.

Helweg, A.
1972. Microbial breakdown of the fungicide benomyl. Soil. Biol. Biochem. 4:377-378.

Helweg, A.
1975. Degradation of ^{14}C-labelled maleic hydrazide in soil as influenced by sterilization, concentration and pretreatment. Weed Res., 15:53-58.

Helweg, A.
1977. Degradation and adsorption of carbendazim and 2-aminobenzimidazole in soil. Pestic. Sci., 8:71-78.

Helweg, A.
1978. Fate of ^{14}C-labelled carbendazim and 2-aminobenzimidazole in soil, described by their degradation rates. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC) V-614.

Hemingway, R.J., P. Hendley, J.A. Davis, and C.A. Spinks.
1978. Residue transfer and metabolism of pirimicarb in hens and a goat. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-518.

Hendrickson, L.L.
1978. Persistence and activity of nitropyrin and its effect on nitrification and plant growth. Dissert. Abstr. 38B(12):5686.

Hensley, D.L., D.S.N. Beuerman, and P.L. Carpenter.
1978. The inactivation of glyphosate by various soils and metal salts. Weed Res., 18:287-291.

Henson, R.D.
1977. Environmental fate of gossyplure. Environ. Entomol., 6(6): 821-822.

Henson, R.D., D.L. Bull, R.L. Ridgway, and G.W. Ivie.
1976. Identification of the oxidative decomposition products of the boll weevil pheromone, grandlure, and the determination of the fate of grandlure in soil and water. J. Agric. Food Chem., 24(2):228-231.

Herberg, R., J. Manthey, L. Richardson, C. Cooley, and A. Donoho.
1978. Excretion and tissue distribution of [^{14}C]monensin in cattle. J. Agric. Food Chem., 26(5):1087-1090.

Herbst, E., I. Scheunert, W. Klein, and F. Korte.
1977. Contributions to ecological chemistry CXXXVIII. Fate of PCBs-^{14}C in sewage treatment - laboratory experiments with activated sludge. Chemosphere, 6(11):725-730.

Herbst, E., I. Scheunert, W. Klein, and F. Korte.
1978. Contributions to Ecological Chemistry CXXXIX. Uptake and conversion of 2,5,4'-trichlorobiphenyl-^{14}C and chloroalkylene-9-^{14}C by goldfish after a single water treatment. Chemosphere, 7(3):221-230.

Herbst, E., I. Weisgerber, W. Klein, und F. Korte.
1976. Beitrage zur okologischen chemie CXVIII. Bilanz, bioakkumulierung und umwandlung von 2,2-dichlorobiphenyl-^{14}C in goldfischen. Chemosphere, 5(2):127-130.

Heritage, A.D., and I.C. MacRae.
1977a. Identification of intermediates formed during the degradation of hexachlorocyclohexanes by Clostridium sphenoides. Appl. Environ. Microbiol., 33(6):1295-1297.

Heritage, A.D., and I.C. MacRae.
1977b. Degradation of lindane by cell-free preparations of Clostridium sphenoides. Appl. Environ. Microbiol., 34(2):222-224.

Hernandez-Crespo, M.S., and C. Rodriquez-Pascual.
1978. Interaction between atrazine and montmorillonite. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-629.

Hess, R.E.
1976. Arsenic chemistry in Missouri soils. Dissert. Abstr., 36(10):4786.

Hesse, S., M. Mezger, and T. Wolff.
1978. Activation of [^{14}C]chlorobiphenyls to protein-binding metabolites by rat liver microsomes. Chem.-Biol. Interact., 20:355-365.

Hewick, D.S., and J. McEwen.
1973. Plasma half-lives, plasma metabolites and anticoagulant efficacies of the enantiomers of warfarin in man. J. Pharm. Pharmac., 25:458-465.

Hilbig, V., K. Lucas, and V. Sebek.
1977. Unterschungen zur elimination und biotransformation von 3-(4-chlorphenyl)-1-methoxy-1-methylharnstoff (Monolinuron) beim schwein. Studies on the elimination and biotransformation of 3-(4-chlorophenyl)-1-methoxy-methy-1-methyl urea (Monolinuron) in the pig. Zbl. Vet. Med. A., 24(4):311-319.

Hill, B.D.
1978. Metabolism of the herbicide benzoylprop ethyl. Dissert. Abstr., 38B(11):5121-5122.

Hill, B.D., and E.H. Stobbe.
1978. Effect of light and nutrient levels on ^{14}C-benzoylprop ethyl metabolism and growth inhibition in wild oat (*Avena fatua* L.). Weed Res., 18:223-229.

Hill, B.D., E.H. Stobbe, and B.L. Jones.
1978. Hydrolysis of the herbicide benzoylprop ethyl by wild oat esterase. Weed Res., 18:149-154.

Hill, D.L.
1971. Enzymatic metabolism of cyclophosphamide. Proc. 62nd Ann. Meeting Amer. Assoc. Cancer Res., 12:67.

Hill, D.L., M.C. Kirk, and R.F. Struck.
1970. Isolation and identification of 4-ketocyclophosphamide, a possible active form of the antitumor agent cyclophosphamide. J. Amer. Chem. Soc., 92(10):3207-3208.

Hill, D.L., W.R. Laster, Jr., and R.F. Struck.
1972. Enzymatic metabolism of cyclophosphamide and nicotine and production of a toxic cyclophosphamide metabolite. Cancer Res., 32:658-665.

Hiltbold, A.E.
1974. Behavior of organoarsenicals in soil. Abstr. 168th ACS Meeting, Atlantic City, NJ, PEST 12.

Hiltbold, A.E., and G.A. Buchanan.
1977. Influence of soil pH on persistence of atrazine in the field. Weed Sci., 25(6):515-520.

Hinderer, R.K.
1975. A comparative study of enzyme activities and cytochrome P-450 levels of various tissues of the rat and Japanese quail with respect to their metabolism of several pesticides. Dissert. Abstr., 36B(2):565.

Hinderer, R.K., and R.E. Menzer.
1976a. Comparative enzyme activities and cytochrome P-450 levels of some rat tissues with respect to their metabolism of several pesticides. Pest. Biochem. Physiol., 6:148-160.

Hinderer, R.K., and R.E. Menzer.
1976b. Enzyme activities and cytochrome P-450 levels of some Japanese quail tissues with respect to their metabolism of several pesticides. Pest. Biochem. Physiol., 6:161-169.

Hinz, R.S.
1973. Degradation of antimycin A by hog liver. Dissert. Abstr., 33B(11):5128.

Hinz, R., and F. Matsumura.
1977. Comparative metabolism of PCB isomers by three species of fish and the rat. Bull. Environ. Contam. Toxicol., 18(5):631-639.

Hirata, M., H. Kagawa, and M. Baba.
1967. Studies on cyclophosphamide. Part I. Chemical determination and degradation kinetics in aqueous media. Shionogi Res. Lab., Ann. Rept., 17:107-113.

Hoagland, R.E.
1978. Isolation and some properties of an aryl acylamidase from red rice, *Oryza sativa* L., that metabolizes 3',4'-dichloropropionanilide. Plant Cell Physiol., 19(6):1019-1027.

Hoben, H.J., S.A. Ching, and L.J. Casarett.
1976a. A study of inhalation of pentachlorophenol by rats. IV. Distribution and excretion of inhaled pentachlorophenol. Bull. Environ. Contam. Toxicol., 15(4):466-474.

Hoben, H.J., S.A. Ching, R.A. Young, and L.J. Casarett.
1976b. A study of the inhalation of pentachlorophenol by rats. Part V. A protein binding study of pentachlorophenol. Bull. Environ. Contam. Toxicol., 16(2):225-232.

Hodgson, J.R., J.C. Hoch, T.R. Castles, D.O. Helton, and C.-C. Lee.
1975. Metabolism and disposition of ferbam in the rat. Toxicol. Appl. Pharmacol., 33(3):505-513.

Hodgson, R.H., K.E. Dusbabek, and B.L. Hoffer.
1973. Diphenamid metabolism in tomato. Abstr. Weed Sci. Soc. Amer., 63.

Hodgson, R.H., and B.L. Hoffer.
1976. Diphenamid metabolism in five crops. Abstr. Weed Sci. Soc. Amer., 82.

Hodgson, R.H., and B.L. Hoffer.
1977a. Diphenamid metabolism in pepper and an ozone effect. I. Absorption, translocation, and the extent of metabolism. Weed Sci., 25(4):324-330.

Hodgson, R.H., and B.L. Hoffer.
1977b. Diphenamid metabolism in pepper and an ozone effect. II. Herbicide metabolite characterization. Weed Sci., 25(4):331-337.

Hoerger, F.D., A.W. Sheldon, H.B. Corbin, M.E. Getzendaner, and G.N. Smith.
1974. Metabolism of tricyclohexyltin hydroxide in animals. Observations on absorption, distribution, and excretion in rats, dogs, cattle and sheep. Abstr. 167th ACS Meeting, Los Angeles, CA, PEST 78.

Hoffman, L.J., J.H. Ross, and J.J. Menn.
1973. Metabolism of 1-(4'-ethylphenoxy)-6,7-epoxy-3,7-dimethyl-2-octene (R 20458) in the rat. J. Agric. Food Chem., 21:156-163.

Hohorst, H.-J., A. Ziemann, und N. Brock.
1965. Alkylierende substanzen in serum und urin nach injektion von cyclophosphamid. Arzneim.-Forsch., 15(4):432-434.

Hohorst, H.-J., A. Ziemann, and N. Brock.
1971. 4-Ketocyclophosphamide, a metabolite of cyclophosphamide. Arzneim.-Forsch., 21(8):1254-1257.

Hollinger, M.A., and S.N. Giri.
1978. Binding of radioactivity from [^{14}C]paraquat to rat lung protein, *in vitro*. Res. Comm. Chem. Pathol. Pharmacol., 19(2): 329-336.

Hollins, J.G., R.F. Willes, F.R. Bryce, S.M. Charbonneau, and I.C. Munro.
1975. The whole body retention and tissue distribution of [^{203}Hg] methylmercury in adult cats. Toxicol. Appl. Pharmacol., 33:438-449.

Holm, R.E., W.-T. Chin, D.H. Wagner, and D.E. Stallard.
1975. Metabolism of thiofanox in cotton plants. J. Agric. Food Chem., 23(6):1056-1060.

Holm, S.
1977. Excretion and metabolism of 2,4,5,2',5'-pentachlorobiphenyl in the squirrel monkey. Food Cosmet. Toxicol., 15:335-336.

Holmstead, R.L.
1976. Studies of the degradation of mirex with an iron (II) porphyrin model system. J. Agric. Food Chem., 24(3):620-624.

Holmstead, R.L., J.E. Casida, L.O. Ruzo, and D.G. Fullmer.
1978a. Pyrethroid photodecomposition: Permethrin. J. Agric. Food Chem., 26(3):590-595.

Holmstead, R.L., T.R. Fukuto, and R.B. March.
1973. The metabolism of *O*-(4-bromo-2,5-dichlorophenyl) *O*-methyl phenylphosphonothioate (leptophos) in white mice and on cotton plants. Arch. Environ. Contam. Toxicol., 1(2): 133-147.

Holmstead, R.L., D.G. Fullmer, and L.O. Ruzo.
1977. Pyrethroid photodecomposition: Pydrin. Abstr. 174th ACS Meeting, Chicago, IL, PEST 6.

Holmstead, R.L., D.G. Fullmer, and L.O. Ruzo.
1978b. Pyrethroid photodecomposition: Pydrin. J. Agric. Food Chem., 26(4):954-959.

Holmstead, R.L., S. Khalifa, and J.E. Casida.
1975. Studies of the reaction of toxaphene and mirex with ferroprotoporphyrin model systems. Abstr. 170th ACS Meeting, Chicago, IL, PEST 131.

Honeycutt, R.C., and I.L. Adler.
1975. Characterization of bound residues of nitrofen in rice and wheat straw. J. Agric. Food Chem., 23(6):1097-1101.

Honeycutt, R.C., G. Boka, J.E. Cassidy, D.P. Ryskiewich, W.S. Secrest, B.J. Simoneaux, and D.D. Sumner.
1978. Removal and characterization of nonextractable metabolites of ϕ-^{14}C-profluralin from field aged soil. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 77.

Hook, J.B., R. Cardona, J.L. Osborn, and M.D. Bailie.
1976. The renal handling of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) in the dog. Food Cosmet. Toxicol., 14:19-23.

Horler, D.F., J.A. Lubkowitz, A.P. Revilla, J. Baruel, and M.M. Cermeli.
1974. Uptake and degradation of monitor by tomato plants. Environ. Qual. Safety, 3(Suppl.):151-156.

Hornish, R.E., and J.L. Nappier.
1977. The excretion and metabolism of 3,4,5-tribromo-*N*,*N*,α-trimethylpyrazole-1-acetamide in the rat. Abstr. 174th ACS Meeting, Chicago, IL, PEST 28.

Hornish, R.E., and J.L. Nappier.
1978. Excretion and metabolism of 3,4,5-tribromo-*N*,*N*, -trimethyl-1H-pyrazole-1-acetamide in the rat. J. Agric. Food Chem., 26(5):1083-1086.

Howells, D.J., J.L. Hambrook, and E.A. Allenby.
1976. Uptake of some volatile alkyl methylphosphonofluoridates from the vapour phase by wheat plants. Pestic. Sci., 7:349-354.

Hsu, J.C., and N.D. Camper.
1975. Degradation of ioxynil and bromoxynil as measured by a modified spectrophotometric method. Can. J. Microbiol., 21: 2008-2012.

Hsu, J.C., and N.D. Camper.
1976. Isolation of ioxynil degraders from soil-enrichment cultures. Can. J. Microbiol., 22(4):537-543.

Hsu, J.C., and N.D. Camper.
1979. Degradation of ioxynil by a soil fungus, *Fusarium solani*. Soil Biol. Biochem., 11:19-22.

Hsu, T., and R. Bartha.
1976. Hydrolyzable and nonhydrolyzable 3,4-dichloroaniline-humus complexes and their respective rates of biodegradation. J. Agric. Food Chem., 24(1):118-122.

Hubbell, J.P., and J.E. Casida.
1977. Metabolic fate of the *N*,*N*-dialkylcarbamoyl moiety of thiocarbamate herbicides in rats and corn. J. Agric. Food Chem., 25(2):404-413.

Huckabee, J.W., S.A. Janzen, B.G. Blaylock, Y. Talmi, and J.J. Beauchamp.
1978. Methylated mercury in brook trout (*Salvelinus fontinalis*): Absence of an *in vivo* methylating process. Trans. Amer. Fish. Soc., 107(6):848-852.

Huhtanen, K., and H.W. Dorough.
1976. Isomerization and Beckmann rearrangement reactions in the metabolism of methomyl in rats. Pestic. Biochem. Physiol., 6:571-583.

Hunt, L.M., W.F. Chamberlain, B.N. Gilbert, D.E. Hopkins, and A.R. Gingrich.
1977. Absorption, excretion, and metabolism of nitrofen by a sheep. J. Agric. Food Chem., 25(5):1062-1065.

Hunt, L.M., and B.N. Gilbert.
1976. Metabolism and residues of ^{3}H- and ^{35}S-labeled ferbam in sheep. J. Agric. Food Chem., 24(3):670-672.

Hutacharern, C.
1975. Action and metabolism of chlorpyrifos in termites. Dissert. Abstr., 36B(3):1057-1058.

Hutacharern, C., and C.O. Knowles.
1975. Metabolism of chlorpyrifos-^{14}C in the eastern subterranean termite. Bull. Environ. Contam. Toxicol., 13(3):351-356.

Hutson, D.H.
1976. Comparative metabolism of dieldrin in the rat (CFE) and in two strains of mouse (CF1 and LACG). Food Cosmet. Toxicol., 14: 577-591.

Hutson, D.H., and J.E. Casida.
1978. Taurine conjugation in metabolism of 3-phenoxybenzoic acid and the pyrethroid insecticide cypermethrin in mouse. Xenobiotica, 8(9):565-571.

Hutson, D.H., J.V. Crayford, and E.C. Hoadley.
1977. The fate of the herbicide flamprop-isopropyl (Barnon) in rats and dogs. Xenobiotica, 7(5):279-300.

Hutson, D.H., D.S. Holmes, and M.J. Crawford.
1976. The involvement of glutathione in the reductive dechlorination of a phenacyl halide. Chemosphere, 5(2):79-84.

Hylin, J.W., J. Shimabukuro, and K. Yanagihara.
1978. The fate of ethylene-bis-dithiocarbamate residues in the agricultural environment. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-617.

Hyzak, D.L.
1973. The rate of degradation of metribuzin and two analogs in soil. Dissert. Abstr., 33B(12):5619.

Iatropoulos, M.J., A. Milling, W.F. Muller, G. Nohynek, K. Rozman, F. Coulston, and F. Korte.
1975. Absorption, transport and organotropism of dichlorobiphenyl (DCB), dieldrin, and hexachlorobenzene (HCB) in rats. Environ. Res., 10:384-389.

Imura, N., S.-K. Pan, M. Shimizu, T. Ukita, and K. Tonomura.
1977. Formation and accumulation of methylmercury in organisms. Ecotoxicol. Environ. Safety, 1:255-261.

Ingram, G.H., and E.M. Pullin.
1974. Persistence of bromoxynil in three soil types. Pestic. Sci., 5:287-291.

Intrieri, C., and K. Ryugo.
1974. Uptake, transport and metabolism of (2-chloroethyl)trimethylammonium chloride in seedlings of almond (*Prunus amygdalus*, Batsch). J. Amer. Soc. Hort. Sci., 99(4):349-352.

Ioannou, Y.M.
1978. *In vitro* metabolism of pyrimidinyl organophosphate insecticides. Dissert. Abstr., 39B(2):542-543.

Ioannou, Y.M., and W.C. Dauterman.
1978. In vitro metabolism of etrimfos by rat and mouse liver. Pestic. Biochem. Physiol., 9:190-195.

Irgolic, K.J., E.A. Woolson, R.A. Stockton, R.D. Newman, N.R. Bottino, R.A. Zingaro, P.C. Kearney, R.A. Pyles, S. Maeda, W.J. McShane, and E.R. Cox.
1977. Characterization of arsenic compounds formed by Daphnia magna and Tetraselmis chuii from inorganic arsenate. Environ. Hlth. Perspec., 19:61-66.

Isensee, A.R., E.R. Holden, E.A. Woolson, and G.E. Jones.
1976. Soil persistence and aquatic bioaccumulation potential of hexachlorobenzene (HCB). J. Agric. Food Chem., 24(6):1210-1214.

Isensee, A.R., P.C. Kearney, E.A. Woolson, G.E. Jones, and V.P. Williams.
1973. Distribution of alkyl arsenicals in model ecosystem. Environ. Sci. Technol., 7(9):841-845.

Ishihara, N., and T. Suzuki.
1976. Biotransformation of methylmercury in vitro. Tohoku J. Exp. Med., 120(4):361-363.

Ishikawa, K., Y. Nakamura, and S. Kuwatsuka.
1976. Degradation of benthiocarb herbicide in soil. J. Pestic. Sci., 1:49-57.

Ishikawa, K., Y. Nakamura, and S. Kuwatsuka.
1977a. Volatilization of benthiocarb herbicide from the aqueous solution and soil. J. Pestic. Sci., 2(2):127-134.

Ishikawa, K., Y. Nakamura, Y. Niki, and S. Kuwatsuka.
1977b. Photodegradation of benthiocarb herbicide. J. Pestic. Sci., 2(1):17-25.

Iverson, F.
1976. Induction of paraoxon dealkylation by hexachlorobenzene (HCB) and mirex. J. Agric. Food Chem., 24(6):1238-1241.

Iverson, F., W.H. Newsome, and S.L. Hierlihy.
1977. Metabolism and excretion of ethylenethiuram monosulfide in the rat. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 47.

Ivey, M.C., S.E. Kunz, and H.D. Mann.
1975. Ethion, ethion monooxon, and ethion dioxon: Residues in the body tissues of turkeys confined in pens on treated soils. J. Econ. Entomol., 68(3):353-354.

Ivey, M.C., and D.E. Oehler.
1976. Gas-liquid chromatographic determination of iodofenphos and several related compounds in tissues and urine of cattle. J. Agric. Food Chem., 24(5):1049-1053.

Ivie, G.W.
1975. Metabolic fate of perfluidone herbicide in a lactating cow. J. Agric. Food Chem., 23(5):869-872.

Ivie, G.W.
1976. Epoxide to olefin: A novel biotransformation in the rumen. Science, 191:959-961.

Ivie, G.W.
1978. Fate of diflubenzuron in cattle and sheep. J. Agric. Food Chem., 26(1):81-89.

Ivie, G.W., and D.L. Bull.
1976. Photodegradation of *O*-ethyl *O*-[4-(methylthio)phenyl] *S*-propyl phosphorodithioate (Bay NTN 9306). J. Agric. Food Chem., 24(5):1053-1057.

Ivie, G.W., D.L. Bull, and D.A. Witzel.
1976a. Metabolic fate of *O*-ethyl *O*-[4-(methylthio)phenyl-^{14}C] *S*-propyl phosphorodithioate (Bay NTN 9306) in a lactating cow. J. Agric. Food Chem., 24(1):147-151.

Ivie, G.W., and J.E. Wright.
1978. Fate of diflubenzuron in the stable fly and house fly. J. Agric. Food Chem., 26(1):90-94.

Ivie, G.W., J.E. Wright, and H.E. Smalley.
1976b. Fate of the juvenile hormone mimic 1-(4'-ethylphenoxy)-3,7-dimethyl-6,7-epoxy-*trans*-2-octene (Stauffer R-20458) following oral and dermal exposure to steers. J. Agric. Food Chem., 24(2):222-227.

Iwan, J., and D. Goller.
1974a. Metabolic fate of chlordimeform in soil under aerobic, anaerobic, and sterile conditions. Environ. Qual. Safety, 3(Suppl.):282-287.

Iwan, J., and D. Goller.
1974b. Behaviour of SN 41703 (prothiocarb) in soils and plants. Environ. Qual. Safety, 3(Suppl.):319-322.

Iwan, J., B. Hertel, and J. Radzuweit.
1977. Transformations of prothiocarb in plant and soil. Neth. J. Pl. Path., 83(Suppl. 1):277-284.

Iwan, J., G.-A. Hoyer, D. Rosenberg, and D. Goller.
1976. Transformations of 4-chloro-*o*-toluidine in soil: Generation of coupling products by one-electron oxidation. Pestic. Sci., 7:621-631.

Iwata, Y., M. Ittig, and F.A. Gunther.
1977. Degradation of *O*,*O*-dimethyl *S*-[α-(carboethoxy)benzyl]phosphorodithioate (phenthoate) in soil. Arch. Environ. Contam. Toxicol., 6:1-21.

Iyer, J.G., G. Chesters, and S.A. Wilde.
1969. Chlorthal degradation in soils and its uptake by pine seedlings. Weed Res., 9:53-61.

Jackson, G.A.
1976. Biologic half-life of endrin in channel catfish tissues. Bull. Environ. Contam. Toxicol., 16(5):505-507.

Jacobs, L.W.
1974. Methylation of mercury in lake and river sediments during field and laboratory investigations. Dissert. Abstr., 34B(9):4156.

Jaglan, P.S., R.E. Gosline, and A.W. Neff.
1976. Metabolic fate of p-toluoyl chloride phenylhydrazone (TCPH) in sheep. The nature of bound residues in erythrocytes. J. Agric. Food Chem., 24(3):659-663.

Jagnow, G., K. Haider, and P.-C. Ellwardt.
1977. Anaerobic dechlorination and degradation of hexachlorocyclohexane isomers by anaerobic and facultative anaerobic bacteria. Arch. Microbiol., 115:285-292.

James, M.O., and J.R. Bend.
1976. Taurine conjugation of 2,4-dichlorophenoxyacetic acid and phenylacetic acid in two marine species. Xenobiotica, 6(7):393-398.

Jansson, B., and A. Bergman.
1978. Sulfur-containing derivatives of hexachlorobenzene (HCB) metabolites in the rat. Chemosphere, 7(3):257-268.

Jarman, M.
1973. Formation of 4-ketocyclophosphamide by the oxidation of cyclophosphamide with $KMnO_4$. Experientia, 29:812-814.

Jeffcoat, B., and W.N. Harries.
1975. Selectivity and mode of action of flamprop-isopropyl, isopropyl (±)-2-[N-(3-chloro-4-fluorophenyl)benzamido]propionate, in the control of Avena fatua in barley. Pestic. Sci., 6:283-296.

Jensen, K.I.N.
1976. Atrazine detoxification in three gramineae subfamilies. Dissert. Abstr., 37B(3):1056.

Jensen, K.I.N., J.D. Bandeen, and V.S. Machado.
1977a. Studies on the differential tolerance of two lamb's-quarters selections to triazine herbicides. Can. J. Plant Sci., 57:1169-1177.

Jensen, K.I.N., G.R. Stephenson, and L.A. Hunt.
1977b. Detoxification of atrazine in three gramineae subfamilies. Weed Sci., 25(3):212-220.

Jensen, S., and B. Jansson.
1976. Anthropogenic substances in seal from the Baltic: Methyl sulfone metabolites of PCB and DDE. Ambio, 5(5-6):257-260.

Jernelov, A., A.H. Johansson, L. Sorensen, and A. Svenson.
1976. Methyl mercury degradation in mink. Toxicol., 6:315-321.

Johannsen, F.R.
1974. Toxicological studies of fluenethyl acaricide. Dissert. Abstr., 35(2):871-872.

Johannsen, F.R., and C.O. Knowles.
1972. Citrate accumulation in two-spotted spider mites, houseflies and mice following treatment with the acaricide 2-fluoro-N-methyl-N-(1-naphthyl)acetamide. J. Econ. Entomol., 65(6):1754-1756.

Johannsen, F.R., and C.O. Knowles.
1974. Metabolism of fluenethyl acaricide in the mouse, housefly, and two-spotted spider mite. J. Econ. Entomol., 67(1):5-12.

Johannsen, F.R., and C.O. Knowles.
1976. Unpublished results, 1972. In: C.O. Knowles, Chemistry and toxicology of quinoxaline, organotin, organofluorine, and formamidine acaricides. Environ. Hlth. Perspect., 14:93-102.
Johannsen, F.R., and C.O. Knowles.
1977. Distribution and metabolism of promecarb in corn following soil application. J. Pestic. Sci., 2(2):159-161.
Johnson, B.T., C.R. Saunders, H.O. Sanders, and R.S. Campbell.
1971. Biological magnification and degradation of DDT and aldrin by freshwater invertebrates. J. Fish. Res. Board Can., 28(5):705-709.
Johnson, D.L.
1972. Bacterial reduction of arsenate in sea water. Nature, 240:44-45.
Johnson, D.L., and R.M. Burke.
1978. Biological mediation of chemical speciation II. Arsenate reduction during marine phytoplankton blooms. Chemosphere, 7(8):645-648.
Johnson, D.L., and M.E.Q. Pilson.
1975. The oxidation of arsenite in seawater. Environ. Lett., 8(2):157-171.
Johnson, E.R., T.C. Yu, and M.L. Montgomery.
1976. Metabolism of triclopyr by grass. Abstr. Weed Sci. Soc. Amer., 82-83.
Jones, A.R., and H. Jackson.
1968. The metabolism of hexamethylphosphoramide and related compounds. Biochem. Pharmacol., 17:2247-2252.
Jordan, L.S., A.A. Zurqiyah, W.A. Clerx, and J.G. Leasch.
1975. Metabolism of terbacil in orange seedlings. Arch. Environ. Contam. Toxicol., 3(3):268-277.
Josting, D., D. Winne, and K.W. Bock.
1976. Glucuronidation of paracetamol, morphine and 1-naphthol in the rat intestinal loop. Biochem. Pharmacol., 25:613-616.
Juengst, F.W., Jr., and M. Alexander.
1975. Effect of environmental conditions on the degradation of DDT in model marine ecosystems. Mar. Biol., 33:1-6.
Juengst, F.W., Jr., and M. Alexander.
1976. Conversion of 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane (DDT) to water-soluble products by mircoorganisms. J. Agric. Food Chem., 24(1):111-115.
Kaaijk, J., and C. Frijlink.
1977. Degradation of S-2-di-isopropylaminoethyl O-ethyl methylphosphonothioate in soil. Sulphur-containing products. Pestic. Sci., 8:510-514.
Kadoum, A.M., and D.W. LaHue.
1976. Degradation of malathion in corn, wheat, and sorghum grain of high moisture content. J. Econ. Entomol., 69(2):205-206.

Kadous, A.A.-R.
1978. Chlorinated hydrocarbon insecticides: Mode of action, resistance mechanisms, and metabolism. Dissert. Abstr., 39B(6): 2652.

Kadunce, R.E., G.E. Stolzenberg, and D.G. Davis.
1974. Metabolism of 2,6-dichloro-4-nitroaniline in soybean tissues. Abstr. 168th ACS Meeting, Atlantic City, NJ, PEST 5.

Kahl, G.F., W. Muller, R. Kahl, H.G. Jonen, and K.J. Netter.
1978. Differential inhibition of biphenyl hydroxylation in perfused rat liver. Naunyn-Schmiedeberg's Arch. Pharmacol., 304:297-301.

Kalberer, P., and E. Vogel.
1978. Residues of carbofuran and 2,3-dihydro-3-hydroxy-2,2-dimethylbenzofuran-7-yl methylcarbamate in the mushroom, *Agaricus bisporus*, cultivated in casing soils treated with the insecticide. Pestic. Sci., 9:146-150.

Kamal, M., W. Klein, and F. Korte.
1976a. Beitrage zur Okologischen Chemie CXXIX. Isolierung und charakterisierung von metaboliten nach langzeitfotterung von 2,2'-dichlorbiphenyl-^{14}C an ratten. Chemosphere, 5:349-356.

Kamal, M., I. Weisgerber, W. Klein, and F. Korte.
1976b. Contributions to ecological chemistry. CXIV. Fate of 2,2'-dichlorobiphenyl-^{14}C in rats upon long-term feeding. J. Environ. Sci. Hlth., B11(4):271-287.

Kamataki, T., M.C.M.L. Lin, D.H. Belcher, and R.A. Neal.
1976. Studies of the metabolism of parathion with an apparently homogeneous preparation of rabbit liver cytochrome P-450. Drug Metab. Dispos., 4(2):180-189.

Kamimura, S., M. Nishikawa, H. Saeki, and Y. Takahi.
1974. Absorption and metabolism of 3-hydroxy-5-methylisoxazole in plants and the biological activities of its metabolites. Phytopath., 64(10):1273-1281.

Kan, C.A., and J.C. Jonker-den Rooyen.
1978. Accumulation and depletion of some organochlorine pesticides in high-producing laying hens. J. Agric. Food Chem., 26(4):935-940.

Kanazawa, J., and C. Tomizawa.
1978. Intake and excretion of 2,4,6-trichlorophenyl-4'-nitrophenyl ether by topmouth gudgeon, *Pseudorasbora parva*. Arch. Environ. Contam. Toxicol., 7:397-407.

Kaneko, H., H. Ohkawa, and J. Miyamoto.
1978. Degradation and movement of permethrin isomers in soil. J. Pestic. Sci., 3(1):43-51.

Kaneko, M., K. Morimoto, and S. Nambu.
1976. The response of activated sludge to a polychlorinated biphenyl (KC-500). Water Res., 10:157-163.

Kaneshima, H., T. Yamaguchi, and K. Itoh.
1978. Studies on the effects of phthalate esters on the biological system: (Part 3). The *in vitro* metabolism of dibutyl phthalate in the small intestines of rats. Bull. Environ. Contam. Toxicol., 20:725-728.

Kao, T.-S., and T.R. Fukuto.
1977. Metabolism of *O*,*S*-dimethyl propionyl- and hexanoylphosphoramidothioate in the house fly and white mouse. Pestic. Biochem. Physiol., 7:83-95.

Kaplanis, J.N., W.E. Robbins, M.J. Thompson, and A.H. Baumhover.
1969. Ecdysone analog: Conversion to alpha ecdysone and 20-hydroxyecdysone by an insect. Science, 166:1540-1541.

Kaplanis, J.N., M.J. Thompson, S.R. Dutky, W.E. Robbins, and E.L. Lindquist.
1972. The metabolism of 4-^{14}C-22,25-bisdeoxyecdysone during larval development in the tobacco budworm, *Manduca sexta* (L.). Steroids, 20:105-120.

Kapoor, I.P.
1978. Metabolism of cytrolane mephosfolan systemic insecticide in plants, animals and the environment. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-512.

Kapoor, I.P., and R.C. Blinn.
1977. Absorption, excretion, and metabolism of cyolane (phosfolan) systemic insecticide [(diethoxyphosphinyl)dithioimidocarbonic acid, cyclic ethylene ester] in the rat. J. Agric. Food Chem., 25(2): 413-417.

Kapoor, S.K., and R.L. Kalra.
1975. Uptake, and metabolism of carbofuran in maize plants. J. Food Sci. Technol., 12:227-230.

Karanth, N.G.K., S.G. Bhat, C.S. Vaidyanathan, and V.N. Vasantharajan.
1976. *p*-Dimethylaminobenzenediazo sodium sulfonate (fenaminosulf)-reductase from *Pseudomonas fragi* Bk$_9$. Pestic. Biochem. Physiol., 6:20-29.

Karapally, J.C., and V.O. Madrid.
1978. Fate of etrimfos [*O*-(6-ethoxy-2-ethyl-4-pyrimidinyl) *O*,*O*-dimethyl phosphorothioate] in the rat and the goat. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-517.

Karunen, P., S. Heinonen, and O. Lyly.
1978. Persistence of mecoprop in northern and southwestern Finland. Rep. Kevo Subarctic Res. Stat., 14:25-30.

Katan, J., T.W. Fuhremann, and E.P. Lichtenstein.
1976. Binding of [^{14}C]parathion in soil: A reassessment of pesticide persistence. Science, 193:891-894.

Katan, J., and E.P. Lichtenstein.
1977. Mechanisms of production of soil-bound residues of [^{14}C] parathion by microorganisms. J. Agric. Food Chem., 25(6):1404-1408.

Kato, Y., Y. Odanaka, S. Teramoto, and O. Matano.
1976. Metabolic fate of ethylenethiourea in pregnant rats. Bull. Environ. Contam. Toxicol., 16(5):546-555.

Kato, Y., K. Sato, M. Hirano, O. Matano, Y. Shirasu, and S. Goto.
1978. Physiological and metabolic elimination of 1-(α,α-dimethylbenzyl)-3-(*p*-tolyl)urea, dimuron in rats. J. Pestic. Sci., 3(1):27-34.

Kaufman, D.D., and C.L. Fletcher.
1974a. Degradation of 4-chloroaniline in nonsterile, sterile, and sterile-inoculated soils. Abstr. 167th ACS Meeting, Los Angeles, CA, PEST 56.

Kaufman, D.D., and C.L. Fletcher.
1974b. Degradation of 4-nitrocatechol in soil. Abstr. 168th ACS Meeting, Atlantic City, NJ, PEST 27.

Kaufman, D.D., and E.G. Jordan.
1976. Permethrin degradation in soil. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 33.

Kaufman, D.D., E.G. Jordan, and A.J. Kayser.
1978a. Degradation of cypermethrin and permethrin in soil. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 47.

Kaufman, D.D., E.G. Jordan, and A.J. Kayser.
1978b. Degradation of ^{14}C-carbonyl- and ^{14}C-methylene permethrin in soil. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 48.

Kaufman, D.D., E.G. Jordan, and A.J. Kayser.
1978c. Degradation of synthetic pyrethroid insecticides (permethrin and cypermethrin) in soil. Abstr. 4th Internat. Contr. Pest. Chem. (IUPAC), Zurich, V-503.

Kawamura, Y., M. Takeda, and M. Uchiyama.
1978. Photolysis of chlorothalonil in benzene. J. Pestic. Sci., 3:397-400.

Kawar, N.S., and S.M. Dagher.
1976. Fate of DDT and parathion in grapes processed into arak, an alcoholic beverage. J. Environ. Sci. Hlth., B11(3):199-210.

Kawar, N.S., F.A. Gunther, and Y. Iwata.
1978. Fate of parathion in artificially fortified grape juice processed into wine. J. Environ. Sci. Hlth., B13(1):1-9.

Kawatski, J.A., and A.E. Zittel.
1977. Accumulation, elimination, and biotransformation of the lampricide 2',5-dichloro-4'-nitrosalicylanilide by *Chironomus tentans*. U.S. Fish Wildl. Serv. Invest. Fish Control, 79.

Kazano, H., M. Asakawa, and C. Tomizawa.
1978. Metabolism of some carbamate insecticides in the green rice leafhopper and the smaller brown planthopper. J. Pestic. Sci., 3:419-425.

Kearney, P.C., A.R. Isensee, and A. Kontson.
1977a. Distribution and degradation of dinitroaniline herbicides in an aquatic ecosystem. Pestic. Biochem. Physiol., 7:242-248.

Kearney, P.C., J.E. Oliver, C.S. Helling, A.R. Isensee, and A. Kontson.
1976a. Distribution, movement, persistence and metabolism of *N*-nitrosoatrazine in soils and an aquatic ecosystem. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 101.

Kearney, P.C., J.E. Oliver, C.S. Helling, A.R. Isensee, and A. Kontson. 1977b. Distribution, movement, persistence, and metabolism of *N*-nitrosoatrazine in soils and a model aquatic ecosystem. J. Agric. Food Chem., 25(5):1177-1181.

Kearney, P.C., J.R. Plimmer, W.B. Wheeler, and A. Kontson. 1976b. Persistence and metabolism of dinitroaniline herbicides in soils. Pestic. Biochem. Physiol., 6:229-238.

Kennedy, J.M., and R.E. Talbert. 1977. Comparative persistence of dinitroaniline type herbicides on the soil surface. Weed Sci., 25(5):373-381.

Kerkenaar, A., and A.K. Sijpesteijn. 1977. On the mode of action of prothiocarb. Neth. J. Pl. Path., 83(Suppl. 1):145-152.

Kern, A.D., W.F. Meggitt, and D. Penner. 1976. Cyanazine metabolism in corn, fall panicum, and green foxtail. Weed Res., 16:119-124.

Khalifa, S., R.L. Holmstead, and J.E. Casida. 1976. Toxaphene degradation by iron(II) protoporphyrin systems. J. Agric. Food Chem., 24(2):277-282.

Khan, M.A.Q. 1978. Metabolism of chlorinated hydrocarbons by fish. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 40.

Khan, S.U. 1977. Adsorption of dyfonate (*O*-ethyl-*S*-phenyl ethylphosphonodithioate) on humic acid. Can. J. Soil Sci., 57:9-13.

Khan, S.U. 1978. Kinetics of hydrolysis of atrazine in aqueous fulvic acid solution. Pestic. Sci., 9:39-43.

Khan, S.U., and T.S. Foster. 1976. Residues of atrazine (2-chloro-4-ethylamino-6-isopropyl amino-*s*-triazine) and its metabolites in chicken tissues. J. Agric. Food Chem., 24(4):768-771.

Khan, S.U., H.A. Hamilton, and E.J. Hogue. 1976a. Fonofos residues in an organic soil and vegetable crops following treatment of the soil with the insecticide. Pestic. Sci., 7:553-558.

Khan, S.U., and P.B. Marriage. 1977a. Residues of atrazine and its metabolites in an orchard soil and their uptake by oat plants. J. Agric. Food Chem., 25(6): 1408-1413.

Khan, S.U., and P.B. Marriage. 1977b. Residues of atrazine and its metabolites in an orchard soil and their uptake by oat plants. Abstr. 174th ACS Meeting, Chicago, IL, PEST 45.

Khan, S.U., P.B. Marriage, and W.J. Saidak. 1976b. Persistence and movement of diuron and 3,4-dichloroaniline in an orchard soil. Weed Sci., 24(6):583-586.

Khan, S.U., and J.C. Young.
1977. *N*-Nitrosamine formation in soil from the herbicide glyphosate. J. Agric. Food Chem., 25(6):1430-1432.

Khasawinah, A.M.A., R.B. March, and T.R. Fukuto.
1978. Insecticidal properties, antiesterase activities, and metabolism of methamidophos. Pestic. Biochem. Physiol., 9:211-221.

Kimmel, E.C., R.H. Fish, and J.E. Casida.
1977. Bioorganotin chemistry. Metabolism of organotin compounds in microsomal monooxygenase systems and in mammals. J. Agric. Food Chem., 25(1):1-9.

King, D.L.
1974. A mechanism of 4-(2,4-dichlorophenoxy)butyric acid selectivity. Dissert. Abstr., 34B(7):3028-3029.

King, D.S.
1972. Metabolism of α-ecdysone and possible percursors by insects *in vivo* and *in vitro*. Gen. Comp. Endocr. (Suppl) 3: 221-227.

Kishk, F.M., T. El-Essawi, S. Abdel-Ghafar, and M.B. Abou-Donia.
1976. Hydrolysis of methylparathion in soils. J. Agric. Food Chem., 24(2):305-307.

Kiso, M., M. Nohta, K. Tanaka, N. Kurihara, T. Fujita, and M. Nakajima.
1977. Insecticidal activity and microsomal metabolism of biooxidizable lindane analogs. Pestic. Biochem. Physiol., 7:341-348.

Klason, P.
1914. Die zummansetzung des arsenhaltigen gases, welches Penicillium-Pilze entivickeln konnen. Chem. Ber. 47:2634-2642.

Kliger, L., and B. Yaron.
1975. Parathion recovery from soils after a short contact period. Bull. Environ. Contam. Toxicol., 13(6):714-719.

Knowles, C.O.
1974a. Formamidine acaricides: Toxicological studies with the cattle tick. 3rd IUPAC Congr. of Pest. Chem. (Helsinki) Environ. Qual. Safety, 3(Suppl.):401-405.

Knowles, C.O.
1974b. Detoxication of acaricides by animals. In: Survival in toxic environments. M.A.Q. Khan and J.P. Bederka, Eds., Academic Press, New York.

Knowles, C.O.
1976. Chemistry and toxicology of quinoxaline, organotin, organofluorine, and formamidine acaricides. Environ. Hlth. Perspec., 14:93-102.

Knowles, C.O., and S.A. Aziz.
1974. Metabolic fate of benzoyl chloride (2,4,6-trichlorophenyl) hydrazone (Banamite acaricide) in the twospotted spider mite. J. Econ. Entomol., 67(5):574-576.

Knowles, C.O., and H.J. Benezet.
1977. Mammalian metabolism of chlordimeform. Formation of metabolites containing the urea moiety. J. Agric. Food Chem., 25(5): 1022-1026.

Knowles, C.O., H.J. Benezet, C.S. Crecelius, and T.L. Johnson.
1978. Degradation of thidiazuron cotton defoliant and its photoproduct in rats, lactating goats and laying hens. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-519.

Knowles, C.O., and F.R. Johannsen.
1976. Metabolism of promecarb in the rat. J. Econ. Entomol., 69(5):595-596.

Knowles, C.O., and C.A. Schuntner.
1974. Effect of piperonyl butoxide on the absorption and metabolism of chlordimeform by larvae of the cattle tick, *Boophilus microplus*. J. Aust. ent. Soc., 13:11-16.

Knox, J.R., S. Khalifa, G.W. Ivie, and J.E. Casida.
1973. Characterization of the photoisomers from *cis*- and *trans*-chlordanes, *trans*-nonachlor and heptachlor epoxide. Tetrahedron, 29:3869-3879.

Kobayashi, K.
1978. Metabolism of pentachlorophenol in fish. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 57.

Kobayashi, K., S. Kimura, and H. Akitake.
1976. Studies on the metabolism of chlorophenols in fish - VII. Sulfate conjugation of phenol and PCP by fish livers. Bull. Jap. Soc. Sci. Fish., 42(2):171-177.

Kobayashi, K., S. Kimura, and E. Shimizu.
1977. Studies on the metabolism of chlorophenols in fish - IX. Isolation and identification of pentachlorophenyl-β-glucuronide accumulated in bile of goldfish. Bull. Jap. Soc. Sci. Fish., 43(4):601-607.

Kocher, H., F. Lingens, und W. Koch.
1976. Untersuchungen zum abbau des herbizids chlorphenpropmethyl im boden und durch mikroorganismen. Weed Res., 16:93-100.

Kohli, J., D. Jones, and S. Safe.
1976a. The metabolism of higher chlorinated benzene isomers. Can. J. Biochem., 54(3):203-208.

Kohli, J., I. Weisgerber, W. Klein, and F. Korte.
1976b. Contributions to ecological chemistry CVII. Fate of Lindane-^{14}C in lettuce, endives and soil under outdoor conditions. J. Environ. Sci. Hlth., B11(1):23-32.

Kohnen, R., K. Haider, and G. Jagnow.
1974. Investigations on the microbial degradation of lindane in submerged and aerated moist soil. Environ. Qual. Safety., 3(Suppl.):222-224.

Koolman, J.
1978. Ecdysone oxidase in insects. Hoppe-Seyler's Z. Physiol. Chem., 359:1315-1321.

Koss, G., and W. Koransky.
1975. Behaviour and biotransformation of ^{14}C-hexachlorobenzene in rats. Arch. Pharmacol., 287:R80.

Koss, G., W. Koransky, and K. Steinbach.
1976. Studies on the toxicology of hexachlorobenzene II. Identification and determination of metabolites. Arch. Toxicol., 35: 107-114.

Koss, G., S. Seubert, A. Seubert, W. Koransky, and H. Ippen.
1978. Studies on the toxicology of hexachlorobenzene. III. Observations in a long-term experiment. Arch. Toxicol., 40:285-294.

Kostyniak, P.J., H.B. Bosmann, and F.A. Smith.
1978. Defluorination of fluoroacetate *in vitro* by rat liver subcellular fractions. Toxicol. Appl. Pharmacol., 44:89-97.

Kozuchowski, J., and D.L. Johnson.
1978. Gaseous emissions of mercury from an aquatic vascular plant. Nature, 274:468-469.

Kramer, S.J., M. Wieten, and C.A.D. de Kort.
1977. Metabolism of juvenile hormone in the Colorado potato beetle, *Leptinotarsa decemlineata*. Insect Biochem., 7:231-236.

Krause, M., and L.P. Van Dyk.
1975. Persistence of phorate and its sulfoxide in cabbages. Phytophylactica, 7:119-120.

Kreminski, S.F., C.K. Brackett, and J.D. Fisher.
1975a. Fate of microbicidal 3-isothiazolone compounds in the environment: Modes and rates of dissipation. J. Agric. Food Chem., 23(6):1060-1068.

Kreminski, S.F., C.K. Brackett, J.D. Fisher, and J.F. Spinnler.
1975b. Fate of microbicidal 3-isothiazolone compounds in the environment: Products of degradation. J. Agric. Food Chem., 23(6):1068-1075.

Krieger, R.I., P.W. Lee, M.A.H. Fahmy, M. Chen, and T.R. Fukuto.
1976a. Metabolism of 2,2-dimethyl-2,3-dihydrobenzofuranyl-7 *N*-dimethoxyphosphinothioyl-*N*-methylcarbamate in the house fly, rat, and mouse. Pestic. Biochem. Physiol., 6:1-9.

Krieger, R.I., A.S. Salhab, P.W. Lee, and T.R. Fukuto.
1976b. Absorption and metabolism of a selective insecticide, 2,2-dimethyl-2,3-dihydrobenzofuranyl-7 *N*-dimethoxyphosphinothioyl-*N*-methylcarbamate, in bean plants. Arch. Environ. Contam. Toxicol., 4(4):483-491.

Krieger, R.I., C.F. Wilkinson, L.J. Hicks, and E.F. Tachenberg.
1976c. Aldrin epoxidation, dihydroisodrin hydroxylation and *p*-chloro-*N*-methyl-aniline demethylation in six species of *Saturniid* larvae. J. Econ. Entomol., 69(1):1-5.

Krueger, H.R.
1975. Phorate sulfoxidation by plant root extracts. Pestic. Biochem. Physiol., 5:396-401.

Krueger, H.R.
1977. Aldicarb sulfoxidation by plant root extracts. Pestic. Biochem. Physiol., 7:154-160.

Ku, C.C., and I.P. Kapoor.
1977. Metabolism of cytrolane mephosfolan systemic insecticide in a simulated rice paddy. Abstr. 174th ACS Meeting, Chicago, IL, PEST 15.

Ku, C.C., I.P. Kapoor, and J.D. Rosen.
1978. Metabolism of cytrolane (mephosfolan) systemic insecticide [(diethoxyphosphinyl)dithioimidocarbonic acid, cyclic propylene ester] in a simulated rice paddy. J. Agric. Food Chem., 26(6):1352-1357.

Kudo, A.
1976. Mercury transfer from bed sediments to freshwater fish (guppies). J. Environ. Qual., 5(4):427-430.

Kudo, A., D.R. Miller, H. Akagi, D.C. Mortimer, A.S. DeFreitas, H. Nagase, D.R. Townsend, and R.G. Warnock.
1978. The role of sediments on mercury transport (total- and methyl-) in a river system. Prog. Wat. Tech., 10(5/6):329-339.

Kuhr, R.J., and A.C. Davis.
1975. Toxicity and metabolism of carbaryl in the European corn borer. Pestic. Biochem. Physiol., 5:330-337.

Kuhr, R.J., and C.W. Hessney.
1977. Toxicity and metabolism of methomyl in the European corn borer. Pestic. Biochem. Physiol., 7:301-308.

Kujawa, M., M. Hartig, R.M. Macholz, and R. Engst.
1976. Der abbau von 14-C-lindan durch eine schimmelpilzkultur. Die Nahrung, 20(2):181-183.

Kujawa, M., R.M. Macholz, und R. Engst.
1974. Metabolismus des lindan. Nachweis von lindan-metaboliten in der leber mit lindan gefutterter ratten. Die Nahrung, 18(5): K25-K27.

Kumar, Y., G.P. Semeluk, P.J. Silk, and I. Unger.
1974. The photochemistry of carbamates IV. The phototransformation of azak (2,6-di-*t*-butyl-4-methylphenyl-*N*-methylcarbamate). Environ. Qual. Safety, 3(Suppl.):302-307.

Kumarasamy, R., and K. Raghu.
1976a. Copper dimethyldithiocarbamate, a degradation product of thiram in soil. Chemosphere, 5(2):107-112.

Kumarasamy, R., and K. Raghu.
1976b. Conversion of the fungicide, ziram in rice plants. Agric. Biol. Chem., 40(11):2297-2298.

Kupelian, R.H.
1975. Bentazon metabolism in soybeans, animals, and soil. Abstr. Weed Sci. Soc. Amer., 82.

Kurihara, N., M. Nohta, K. Tanaka, M. Kiso, T. Fujita, and M. Nakajima.
1977a. Metabolic detoxication and synergistic ratio of lindane analogs in house flies. Pestic. Biochem. Physiol., 7:332-340.

Kurihara, N., K. Tanaka, and M. Nakajima.
1976. Isomerization of hexachlorocyclohexene. Agric. Biol. Chem., 40(2):411-413.

Kurihara, N., K. Tanaka, and M. Nakajima.
1977b. Pathways of chlorophenyl-mercapturic acids formation in biodegradation of lindane. Agric. Biol. Chem., 41(7):1317-1319.

Kurihara, N., K. Tanaka, and M. Nakajima.
1978. Anaerobic microsomal metabolism of lindane and related compounds: Reductive dechlorination and dehydrochlorination, its significance in the *in vivo* metabolism. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-7.

Kuroki, H., and Y. Masuda.
1977. Structures and concentrations of the main components of polychlorinated biphenyls retained in patients with Yusho. Chemosphere, 6(8):469-474.

Kurozumi, A., T. Kurokawa, I. Yamaguchi, and T. Misato.
1978. Phosphorylation of 3,3'-dimethyl-4-hydroxybenzophenone by soil microorganism (*Bacillus* sp.). J. Pestic. Sci., 3(1): 59-60.

Kurtz, D.A., and J.L. George.
1976. DDT metabolism in Pennsylvania white-tail deer. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 88.

Kuwatsuka, S., and M. Igarashi.
1975. Degradation of PCP in soils II. The relationship between the degradation of PCP and the properties of soils, and the identification of the degradation products of PCP. Soil Sci. Plant Nutr., 21(4):405-414.

Kuwatsuka, S., and Y. Niki.
1976. Fate and behavior of herbicides in soil environments with special emphasis on the fate of principal paddy herbicides in flooded soils. Rev. Plant Protec. Res., 9:143-163.

Kuwatsuka, S., M. Oyamada, and Y. Niki.
1973. Degradation of diphenyl ether herbicides in soils. Abstr. 1973 Meet., Agr. Chem. Soc. Japan, 83 (In Japanese). From Y. Niki and S. Kuwatsuka, Degradation of diphenyl ether herbicides in soils. Soil Sci. Plant Nutr., 22(3):223-232 (1976).

Kuwatsuka, S., M. Oyamada, and H. Shimotori.
1978. Metabolic fate of CNP, a diphenyl ether herbicide, in soil and by isolated soil microorganisms. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-504.

Labrecque, G.C., M.C. Bowman, R.S. Patterson, and J.A. Seawright.
1972. Persistence of thiotepa and tepa in pupae and adults of *Culex pipiens fatigans* Wiedemann. Bull. Wld. Hlth. Org., 47: 675-676.

Lachaise, F., and R. Feyereisen.
1976. Metabolisme de l'ecdysone par divers organes de *Carcinus maenas* L. incubes *in vitro*. C.R. Acad. Sci. Ser. D., 283:1445-1448.

Ladlie, J.S., W.F. Meggitt, and D. Penner.
1974. Metribuzin activity as related to soil pH. Abstr. Weed Sci. Soc. Amer., 121.

Ladlie, J.S., W.F. Meggitt, and D. Penner.
1976a. Effect of soil pH on microbial degradation, adsorption, and mobility of metribuzin. Weed Sci., 24(5):477-481.

Ladlie, J.S., W.F. Meggitt, and D. Penner.
1976b. Role of pH on metribuzin dissipation in field soils. Weed Sci., 24(5):508-511.

Lafleur, K.S., W.R. McCaskill, and G.T. Gale, Jr.
1978. Trifluralin persistence in Congaree soil. Soil Sci., 126(5):285-289.

Lakso, J.U., and S.A. Peoples.
1975. Methylation of inorganic arsenic by mammals. J. Agric. Food Chem., 23(4):674-676.

Lamberton, J.G., R.D. Inman, and R.R. Claeys.
1975. The metabolism of p,p'-DDE in laying Japanese quail and their incubated eggs. Bull. Environ. Contam. Toxicol., 14(6): 657-664.

Lamoureux, G.L., and K.L. Davison.
1975. Mercapturic acid formation in the metabolism of propachlor, CDAA, and fluorodifen in the rat. Pestic. Biochem. Physiol., 5: 497-506.

Lamoureux, G.L., and D.G. Rusness.
1976. Pentachloronitrobenzene (PCNB) metabolism in peanut. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 106.

Lamoureux, G.L., and L.E. Stafford.
1977. Translocation and metabolism of perfluidone (1,1,1-trifluoro-N-[2-methyl-4-(phenylsulfonyl)phenyl]methanesulfonamide) in peanuts. J. Agric. Food Chem., 25(3):512-517.

Larsen, G.L., and J.E. Bakke.
1974. Characterization of rat urinary metabolites of terbutryn by mass spectrometry. Abstr. 168th ACS Meeting, Atlantic City, NJ, PEST 4.

Larsen, G.L., and J.E. Bakke.
1978. Mass spectral characterization of the glucuronide conjugates of terbutryn [2-(t-butylamino)-4-(ethylamino)-6-(methylthio)-s-triazine] metabolites from rats and goat. Biomed. Mass Spectro., 5(6):391-394.

Larsen, G.L., J.E. Bakke, and B.E. Gustafsson.
1978. The role of enterohepatic circulation in the formation of the metabolites of 2-chloro-N-isopropylacetanilide (propachlor). Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-520.

Larson, L.L.
1976. The selective toxicity of orthene. Dissert. Abstr., 36B(12):5959.

Lavee, S., and G.C. Martin.
1974a. Ethephon [1,2-^{14}C(2-chloroethyl)phosphonic acid] in peach fruits. I. Penetration and persistence. J. Amer. Soc. Hort. Sci., 99(2):97-99.

Lavee, S., and G.C. Martin.
1974b. Ethephon [1,2-^{14}C(2-chloroethyl)phosphonic acid] in peach fruits. II. Metabolism. J. Amer. Soc. Hort. Sci., 99(2):100-103.

Lay, M.-M., and J.E. Casida.
1976. Dichloroacetamide antidotes enhance thiocarbamate sulfoxide detoxication by elevating corn root glutathione content and glutathione *S*-transferase activity. Pestic. Biochem. Physiol., 6:442-456.

Lay, M.-M., J.P. Hubbell, and J.E. Casida.
1977. Glutathione and glutathione *S*-transferases in thiocarbamate herbicide antidote action. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 70.

Lay, M.M., A.M. Niland, J.R. DeBaun, and J.J. Menn.
1978. Metabolism of the thiocarbamate herbicide, molinate, in fish. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 43.

Leahey, J.P., and R.J. Hemingway.
1974. The metabolism of diquat in hens and residues in eggs and tissues. Environ. Qual. Safety, 3(Suppl.):157-162.

Leather, G.R.
1976. Absorption, distribution and metabolism of bifenox. Dissert. Abstr., 36(11):5830.

Leather, G.R., and C.L. Foy.
1977. Metabolism of bifenox in soil and plants. Pestic. Biochem. Physiol., 7:437-442.

Lee, A.H., P.-Y. Lu, R.L. Metcalf, and E.-L. Hsu.
1976. Environmental fate of three dichlorophenyl nitrophenyl ether herbicides in a rice paddy model ecosystem. J. Environ. Qual., 5(4):482-486.

Lee, G.F., R.A. Hughes, and G.D. Veith.
1977. Evidence for partial degradation of toxaphene in the aquatic environment. Water Air Soil Pollut., 8:479-484.

Lee, P.W.
1977. Toxicology and metabolism of the chiral enantiomers of *O*-ethyl *S*-phenyl ethylphosphonodithioate (Fonofos) and oxygen analogs. Dissert. Abstr., 37(12):5958-5959.

Lee, P.W., R. Allahyari, and T.R. Fukuto.
1978a. The chemistry, metabolism, and toxicological properties of the chiral isomers of fonofos. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 78.

Lee, P.W., R. Allahyari, and T.R. Fukuto.
1978b. Studies on the chiral isomers of fonofos and fonofos oxon: II. *In vitro* metabolism. Pestic. Biochem. Physiol., 8:158-169.

Lee, P.W., R. Allahyari, and T.R. Fukuto.
1978c. Studies on the chiral isomers of fonofos and fonofos oxon: III. *In vivo* metabolism. Pestic. Biochem. Physiol., 9:23-32.

Lee, P.W., and T.R. Fukuto.
1976. Penetration and comparative metabolism of leptophos in susceptible and resistant houseflies. Arch. Environ. Contam. Toxicol., 4(4):443-455.

Leidy, R.B., J.J. Domanski, P.L. Haire, and T.J. Sheets.
1977. Effects of weathering and flue-curing on methomyl residues on tobacco. Arch. Environ. Contam. Toxicol., 5(2):199-206.

Leistra, M., J.H. Smelt, and T.M. Lexmond.
1976. Conversion and leaching of aldicarb in soil columns. Pestic. Sci., 7:471-482.

LePatourel, G.N.J., and D.J. Wright.
1974a. Uptake and metabolism of phorate by the free-living nematode *Panagrellus redivivus*. Pestic. Biochem. Physiol., 4(2):135-143.

LePatourel, G.N.J., and D.J. Wright.
1974b. Studies on the mechanisms of accumulation of phorate by the free-living nematode *Panagrellus redivivus*. Pestic. Biochem. Physiol., 4(2):144-152.

LePatourel, G.N.J., and D.J. Wright.
1974c. Organophosphorus pesticide metabolism associated with nematodes: The role of bacteria. Nematologica, 20(1):104-106.

Leuck, D.B., R.L. Jones, and M.C. Bowman.
1975. Chlorpyrifos-methyl insecticide residues: Their analysis and persistence in coastal bermudagrass and forage corn. J. Econ. Entomol., 68(3):287-290.

Levine, B.S., and S.D. Murphy.
1977. Effect of piperonyl butoxide on the metabolism of dimethyl and diethyl phosphorothionate insecticides. Toxicol. Appl. Pharmacol., 40:393-406.

Levy, C.C.
1964. Metabolism of coumarin by a micro-organism: O-Coumaric acid as an intermediate between coumarin and melilotic acid. Nature, 204:1059-1061.

Lewis, D.L., D.F. Paris, and G.L. Baughman.
1975. Transformation of malathion by a fungus, *Aspergillus oryzae*, isolated from a freshwater pond. Bull. Environ. Contam. Toxicol., 13(5):596-601.

Lewis, R.J., and W.F. Trager.
1970. Warfarin metabolism in man: Identification of metabolites in urine. J. Clin. Invest., 49:907-913.

Li, C.F., and R.L. Bradley, Jr.
1969. Degradation of chlorinated hydrocarbon pesticides in milk and butteroil by ultraviolet energy. J. Dairy Sci., 52(1): 27-30.

Li, C.Y.
1977. Conversion of *p*-coumaric acid to caffeic acid and of *p*-hydroxyphenylacetic acid to 3,4-dihydroxyphenylacetic acid by *Alnus rubra*. Lloydia, 40(3):298-300.

Liang, T.T., and E.P. Lichtenstein.
1976. Effects of soils and leaf surfaces on the photodecomposition of [^{14}C]azinphosmethyl. J. Agric. Food Chem., 24(6):1205-1210.

Liberti, A., D. Brocco, I. Allegrini, A. Cecinato, and M. Possanzini.
1978. Solar and UV photodecomposition of 2,3,7,8-tetrachloro dibenzo-*p*-dioxin in the environment. Sci. Total Environ., 10:97-104.

Lichtenstein, E.P., T.T. Liang, and T.W. Fuhremann.
1978. A compartmentalized microcosm for studying the fate of chemicals in the environment. J. Agric. Food Chem., 26(4):948-953.

Lichtenstein, E.P., H. Parlar, F. Korte, and A. Suss.
1977a. Identification of [^{14}C]fonofos metabolites isolated from insecticide-treated culture media of the soil fungus *Rhizopus japonicus*. J. Agric. Food Chem., 25(4):845-848.

Lichtenstein, E.P., K.R. Schulz, and T.T. Liang.
1977b. Fate of fresh and aged soil residues of the insecticide [^{14}C]-N-2596 in a soil-corn-water ecosystem. J. Econ. Entomol., 70(2):169-175.

Lin, T.H., R.E. Menzer, and H.H. North.
1976. Metabolism in human embryonic lung cell cultures of three phenylurea herbicides: Chlorotoluron, fluometuron and metobromuron. J. Agric. Food Chem., 24(4):759-763.

Lingens, F., R. Blecher, H. Blecher, and U. Koch.
1977. Isolation of chloridazron-degrading bacteria from soil of East Africa (Kenya). J. Plant Dis. Protect., 84(11):684-690.

Liu, L.-C., R.H. Shimabukuro, and J.D. Nalewaja.
1978. Diuron metabolism in two sugarcane (*Saccharum officinarum*) cultivars. Weed Sci., 26(6):642-646.

Locke, R.K., J.-Y.T. Chen, J.N. Damico, L.R. Dusold, and J.A. Sphon.
1976. Identification by physical means of organic moieties of conjugates produced from carbaryl by tobacco cells in suspension culture. Arch. Environ. Contam. Toxicol., 4(1):60-100.

Loeffler, J.E., J.C. Potter, S.L. Scordelis, H.R. Hendrickson, C.K. Huston, and A.C. Page.
1976. Long-term exposure of swine to a [^{14}C]dichlorvos atmosphere. J. Agric. Food Chem., 24(2):367-371.

Loeffler, R.S.T.
1978. Identification of the photochemical decomposition product of chlorothalonil by ^{13}C n.m.r. spectroscopy. Pestic. Sci., 9:310-312.

Lores, E.M., G.W. Sovocool, R.L. Harless, N.K. Wilson, and R.F. Moseman. 1977. A new metabolite of chlorpyrifos: Isolation and identification. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 50.

Lores, E.M., G.W. Sovocool, R.L. Harless, N.K. Wilson, and R.F. Moseman. 1978. A new metabolite of chlorpyrifos: Isolation and identification. J. Agric. Food Chem., 26(1):118-121.

Lucier, G.W., O.S. McDaniel, C.M. Schiller, and H.B. Matthews. 1978. Structural requirements for the accumulation of chlorinated biphenyl metabolites in the fetal rat intestine. Drug Metab. Dispos., 6(5):584-590.

Lui, H., and G.D. Sweeney. 1975. Hepatic metabolism of hexachlorobenzene in rats. FEBS Lett., 51(1):225-226.

Luke, B.G., and C.J. Dahl. 1976. Detection of *O,O*-diethyl-*O*-(2,5-dichlorophenyl)phosphorothioate and *O,O*-diethyl-*O*-(3,6-dichloro-2-pyridyl)phosphorothioate in meat fat. J. Assoc. Off. Anal. Chem., 59(5):1081-1087.

Lunde, G. 1973. The synthesis of fat and water soluble arseno organic compounds in marine and limnetic algae. Acta Chemica Scand., 27:1586-1594.

Lunde, G. 1975a. Isolation of an organoarsenic compound present in cod liver. J. Sci. Food Agric., 26:1247-1255.

Lunde, G. 1975b. A comparison of organoarsenic compounds from different marine organisms. J. Sci. Food Agric., 26:1257-1262.

Lunde, G. 1977. Occurrence and transformation of arsenic in the marine environment. Environ. Hlth. Perspec., 19:47-52.

Lusby, W.R., P.C. Kearney, A. Kontson, D. Conley, and J.E. Oliver. 1978. Metabolism of α,α,α-trifluoro-2,6-dinitro-*p*-toluidine by Streptomyces sp. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 79.

Lutz, R.J., R.L. Dedrick, H.B. Matthews, T.E. Eling, and M.W. Anderson. 1977. A preliminary pharmacokinetic model for several chlorinated biphenyls in the rat. Drug Metab. Dispos., 5(4):386-396.

Lynch, M.J., and S.K. Figdor. 1977. Tissue residue and comparative metabolism studies on tiazuril in the chicken, rat, dog, and monkey. J. Agric. Food Chem., 25(6): 1344-1353.

Lynch, V.P. 1974. A method for the determination of guazatine residues in crops and soil. Environ. Qual. Safety, 3(Suppl.):124-128.

Lyon, J., S. Hawley, S. Leibovic, T. Lindall, G. Morgan, J. Pfotenhauer, D. Platika, D. Williams, and C. Zeiger. 1975. Photochemistry of DDT and toxicity of its photodegradative product, 4,4'-dichlorobiphenyl, on trout. Proj. Rpt. Abst. NSF-SOS Grant No. 7508997. Reed College, Portland, OR.

Maasen, A.

1902. Die biologische methode Gosio's zum nachweis des arsens und die bildung organischer arsen-, selen-, und tellurverbindungen durch schimmelpilze und bacterien. Arb. kaiserlich. Gesundheit., 18(1):475-489.

Maass, W.S.G., O. Hutzinger, and S. Safe.

1976. Metabolism of 4-chlorobiphenyl by lichens. Arch. Environ. Contam. Toxicol., 3(4):470-478.

Mabey, W.R., A. Baraze, B.Y. Lan, H. Richardson, D.G. Hendry, and T. Mill.

1976. The fate of methyl parathion in freshwater systems: II. Hydrolysis and photolysis. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 61.

MacDonald, K.B., R.B. McKercher, and J.R. Moyer.

1976. Picloram displacement in soil. Soil Sci., 121(2):94-102.

MacDonald, R.L.

1976. Biochemistry of resistance to parathion and fenthion in strains of houseflies. Dissert. Abstr., 37B(6):2655.

Machin, A.F., P.H. Anderson, L.C. Howells, and D.E. Mundy.

1978. Enzymic degradation of phosphorothionate oxons in the plasma of species of varying susceptibility to poisoning. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-620.

Machin, A.F., D.E. Mundy, M.P. Quick, and N.F. Janes.

1974. Esterase-inhibiting photo-oxidation products from the organophosphorus insecticide pyrimithate. Pestic. Sci., 5:741-748.

Machin, A.F., H. Rogers, A.J. Cross, M.P. Quick, L.C. Howells, and N.F. Janes.

1975. Metabolic aspects of the toxicology of diazinon. I. Hepatic metabolism in the sheep, cow, pig, guinea-pig, rat, turkey, chicken, and duck. Pestic. Sci., 6:461-473.

Mackrell, J.A., and J.R.L. Walker.

1978. The biodegradation of quaternary ammonium compounds. Int. Biodeterior Bull., 14(3):77-83.

MacNeil, J.D., and M. Hikichi.

1976. Degradation of endosulfan and ethion on pears and pear and grape foliage. J. Agric. Food Chem., 24(3):608-611.

Maeda, S., S. Uchida, and T. Kisaki.

1978. Microbial degradation of nicotine-N'-oxide. I. Degradation products. Agric. Biol. Chem., 42(8):1455-1460.

Magee, L.A., and A.R. Colmer.

1966. Oxidation of maleic hydrazide and diethanolammonium maleic hydrazide by Alcaligenes faecalis. Miss. Acad. Sci. J., 12:166-169.

Magnussen, J.D., and D.P. Rainey.

1977. Metabolism of tebuthiuron in range grasses. Abstr 173rd ACS Meeting, New Orleans, LA, PEST 43.

Magos, L., and W.H. Butler.
1976. The kinetics of methylmercury administered repeatedly to rats. Arch. Toxicol., 35:25-39.

Mahoney, M.D., and D. Penner.
1975. Bentazon translocation and metabolism in soybean and navy bean. Weed Sci., 23(4):265-271.

Mallipudi, N.M.
1978. Toxicity and mode of action of *N*-sulfenylated derivatives of insecticidal methylcarbamate esters in the honey bee. Dissert. Abstr., 39B(5):2123.

Mangest, B.L., F.W. Slife, and C.E. Rieck.
1976. Differential metabolism of metribuzin by two soybean cultivars. Abstr. Weed Sci. Soc. Amer., 73-74.

Manley, G.V., J.W. Butcher, and M. Zabik.
1976. DDT transfer and metabolism in a forest litter macroarthropod food chain. Pedobiologia, 16:81-98.

Mansour, M., and F. Korte.
1976. Beitrage zur Okologischen Chemie CXXXI. Zur photochemie der chlorierten aniline und phenole in losung. Chemosphere, 5:383-388.

Mansour, M., H. Parlar, and F. Korte.
1975. Beitrage zur Okologischen Chemie CI. Reaktionsverhalten von 3,4-dichloranilin und 3,4-dichlorphenol in losung, als festkorper und in der gasphase bei UV-bestrahlung. Chemosphere, 4(4):235-240.

Mansuy, D., M. Lange, and J.C. Chottard.
1978. Reaction of 2,2-bis(*p*-chlorophenyl)-1,1,1-trichloroethane (DDT) with iron (II) porphyrins. Isolation of the vinylidene carbene complex, tetraphenylporphyriniron (II) (C=C(*p*-Cl-C_6H_4)$_2$). J. Amer. Chem. Soc., 100(10):3213-3214.

Marco, G.J., and G.D. Dupre.
1973. Translocation and transformation of *N*-(cyclopropylmethyl)-α,α,α-trifluoro-2,6-dinitro-*N*-propyl-*p*-toluidine (CGA-10832) by cotton, soybeans, soil, and physico-chemical conditions. Abstr. Weed Sci. Soc. Amer., 55.

Marei, A.H., J.W. Higham, and R.C. Blinn.
1975. Cycocel plant growth regulant. Fate of carbon-14 chlorocholine chloride in sugarcane grown in Hawaii. J. Agric. Food Chem., 23(6):1118-1120.

Marei, A.S.M., J.M.E. Quirke, G. Rinaldi, J.A. Zoro, and G. Eglinton.
1978. The environmental fate of DDT. Chemosphere, 7(12): 993-998.

Maroder, H.L., and I.A. Prego.
1971. Transformation of picloram in *Prosopis ruscifolia* and *Diplotaxis tenuifolia*. Weed Res., 11:193-195.

Marquis, L.Y.
1976. Fluchloralin metabolism in soybean. Abstr. Weed Sci. Soc. Amer., 68-69.

Marquis, L.Y.
1977. The metabolism and selectivity of fluchloralin in soybean. Dissert. Abstr., 37B(11):5477.

Marriage, P.B., S.U. Khan, and W.J. Saidak.
1977. Persistence and movement of terbacil in peach orchard soil after repeated annual applications. Weed Res., 17:219-225.

Marshall, R.S., and C.F. Wilkinson
1973. The interaction of insecticide synergists with nonenzymatic model oxidation systems. Pestic. Biochem. Physiol., 2(4):425-436.

Marshall, T.C., and H.W. Dorough.
1977. Bioavailability in rats of bound and conjugated plant carbamate insecticide residues. J. Agric. Food Chem., 25(5):1003-1009.

Marshall, W.D.
1977a. Oxidative inactivation of ethylenbisdithiocarbamate fungicides and their toxic decomposition products ethylenethiuram monosulfide and ethylenethiourea. Abstr. 174th ACS Meeting, Chicago, IL, PEST 9.

Marshall, W.D.
1977b. Thermal decomposition of ethylenebisdithiocarbamate fungicides to ethylenethiourea in aqueous media. J. Agric. Food Chem., 25(2):357-361.

Marshall, W.D.
1978. Oxidation of ethylenebisdithiocarbamate fungicides and ethylenethiuram monosulfide to prevent their subsequent decomposition to ethylenethiourea. J. Agric. Food Chem., 26(1): 110-115.

Marshall, W.D., and J. Singh.
1977. Oxidative inactivation of ethylenethiourea by hypochlorite in alkaline medium. J. Agric. Food Chem., 25(6):1316-1320.

Martens, R.
1976. Degradation of [8,9-^{14}C]endosulfan by soil microorganisms. Appl. Environ. Microbiol., 36(6):853-858.

Martens, R.
1977. Degradation of endosulfan-8,9-^{14}C in soil under different conditions. Bull. Environ. Contam. Toxicol., 17(4):438-446.

Martens, R.
1978. Degradation of the herbicide [^{14}C]-dichlofop-methyl in soil under different conditions. Pestic. Sci., 9:127-134.

Martz, F., and J.A. Straw.
1977. The *in vitro* metabolism of 1-(*o*-chlorophenyl)-1-(*p*-chlorophenyl)-2,2-dichloroethane (*o,p*'-DDD) by dog adrenal mitochondria and metabolite covalent binding to mitochondrial macromolecules. Drug Metab. Dispos., 5(5):482-486.

Maruszewska, M., and H. Gertig.
1977. Badania nad przebiegiem rozkladu karbarylu w roztworach modelowych. (Studies on decomposition of carbaryl in model solutions.) Bromat. Chem. Toksykol., 10(3):257-262.

Marvel, J.T., L.A. Suba, B.B. Brightwell, M.L. Sutherland, L.B. Colvin, J.A. Miller, T.G. Curtis, C. Ho, and N. Chen.
1975. The metabolic fate of the ripener glyphosine in sugarcane, animals and the environment. Abstr. 170th ACS Meeting, Chicago, IL, PEST 137.

Mason, W.A., and C.E. Meloan.
1976. Degradation products of phoxim (Bay 77488) on stored wheat. J. Agric. Food Chem., 24(2):299-304.

Masuda, T., and J. Kanazawa.
1973. Residues of Kitazin P metabolite in rice plants and soil. Agric. Biol. Chem., 37(12):2931-2932.

Mate, C., A.J. Ryan, and S.E. Wright.
1967. Metabolism of some 4-nitroaniline derivatives in the rat. Food Cosmet. Toxicol., 5:657-663.

Mathur, S.P., and H.V. Morley.
1975. A biodegradation approach for investigating pesticide incorporation into soil humus. Soil Sci., 120(3):238-240.

Mathur, S.P., and H.V. Morley.
1978. Incorporation of methoxychlor-^{14}C in model humic acids prepared from hydroquinone. Bull. Environ. Contam. Toxicol., 20:268-274.

Mathur, S.P., and J.G. Saha.
1977. Degradation of lindane-^{14}C in a mineral soil and in an organic soil. Bull. Environ. Contam. Toxicol., 17(4):424-430.

Matsumura, F.
1978. Degradation of pesticides by algae and aquatic microorganisms. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 41.

Matsumura, F., H.J. Benezet, and K.C. Patil.
1976. Factors affecting microbial metabolism of γ-BHC. J. Pestic. Sci., 1(1):3-8.

Matsumura, F., Y.G. Doherty, K. Furukawa, and G.M. Boush.
1975. Incorporation of ^{203}Hg into methylmercury in fish liver: Studies on biochemical mechanisms in vitro. Environ. Res., 10: 224-235.

Matthews, E.W., and S.D. Faust.
1977. The hydrolysis of zectran in buffered and natural waters. J. Environ. Sci. Hlth., B12(2):129-146.

Matthiessen, P.
1977. Uptake, metabolism and excretion of the molluscicide N-tritylmorpholine by the tropical food fish Sarotherodon mossambicus (Peters). J. Fish. Biol., 11:497-509.

Mauck, W.L., L.E. Olson, and J.W. Hogan.
1977. Effects of water quality on deactivation and toxicity of mexacarbate (Zectran) to fish. Arch. Environ. Contam. Toxicol., 6:385-393.

Mayer, P.
1978. Metabolism of C 18898 in paddy rice. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-507.

Mayer, P., and T.L. Laanio.
1978. Metabolism of C19490 in paddy rice. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-508.

Mayer, R.T., and M.D. Burke.
1976. Albumin and cytochrome P_{450} binding characteristics of juvenile hormone and its analogs. Pestic. Biochem. Physiol., 6:377-385.

Mayer, R.T., and R.A. Prough.
1976. Characterization of a metabolite-cytochrome P-450 complex derived from the aerobic metabolism of an insect juvenile hormone analog by rat microsomal fractions. Toxicol. Pharmacol., 38:439-454.

Mayer, R.T., J.A. Svoboda, and G.F. Weirich.
1978. Ecdysone 20-hydroxylase in midgut mitochondria of *Manduca sexta* (L.). Hoppe-Seyler's Z. Physiol. Chem., 359: 1247-1257.

Mayo, B.C., R.R. Brodie, L.F. Chasseaud, and D.R. Hawkins.
1978. Biotransformation of methyl-5-cyclopropylcarbonyl-2-benzimidazolecarbamate (ciclobendazole) in rats and dogs. Drug Metab. Dispos. (6(5):518-527.

McBain, J.B., A.D. Gutman, J.P. Wren, and J.J. Menn.
1978. Metabolism and environmental degradation of 4-[*O*-(*O*,*O*-diethyl phosphorothio)yl] acetophenoneoxime-*N*'-methylcarbamate (R-14805) by rats, water, and sunlight. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-510.

McBride, B.C., and R.S. Wolfe.
1971. Biosynthesis of dimethylarsine by methanobacterium. Biochem., 10(23):4312-4317.

McGahen, L.L., and J.M. Tiedje.
1978. Metabolism of two new acylanilide herbicides, antor herbicide (H-22234) and dual (metolachlor) by the soil fungus *Chaetomium globosum*. J. Agric. Food Chem., 26(2):414-419.

McGovern, J.P., W.C. Lubawy, and H.B. Kostenbauder.
1976. Uptake and metabolism of nicotine by the isolated perfused rabbit lung. J. Pharmacol. Exp. Ther., 199(1):198-207.

McKellar, R.L., H.J. Dishburger, J.R. Rice, L.F. Craig, and J. Pennington.
1976. Residues of chlorpyrifos, its oxygen analogue, and 3,5,6-trichloro-2-pyridinol in milk and cream from cows fed chlorpyrifos. J. Agric. Food Chem., 24(2):283-286.

McPherson, F.J., A. Markham, J.W. Bridges, G.C. Hartman, and D.V. Parke.
1975. A comparison of the properties *in vitro* of biphenyl 2- and 4-hydroxylase in the mesocarp from avocado pear (*Persea americana*) and Syrian-hamster hepatic tissue. Biochem. Soc. London Trans., 3(2):281-283.

Meallier, P., J. Nury, B. Pouyet, C. Coste, and J. Bastide. 1977a. Photodegradation des molecules organiques phytosanitaires I - Proprietes spectroscopiques du parathion. Chemosphere, 6(12): 809-814.

Meallier, P., J. Nury, B. Pouyet, C. Coste, and J. Bastide. 1977b. Photodegradation des molecules phytosanitaires II - Cinetique et mecanisme de photodegradation du parathion. Chemosphere, 6(12):815-820.

Meeks, J.R., and D.E. Stallard. 1978a. Metabolism of thiofanox in a pond water ecosystem. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 56.

Meeks, J.R., and D.E. Stallard. 1978b. Metabolism of thiofanox in potato tubers. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 46.

Mehta, C.S., and J.W. McGinity. 1977. Chronic administration of cyanide: Urinary excretion of thiocyanate in male and female rats. Acta Pharmacol. Toxicol., 41:49-52.

Meikle, R.W. 1977. Fate of diamidafos (phenyl *N*,*N*'-dimethylphosphordiamidate) in tobacco, cured tobacco, and in smoke. J. Agric. Food Chem., 25(4):746-752.

Meikle, R.W. 1978. The hydrolysis rate of diamidafos in dilute aqueous solution. Bull. Environ. Contam. Toxicol., 19:589-599.

Meikle, R.W., D.A. Laskowski, A.J. Regoli, and C.T. Redemann. 1978. The hydrolysis and photolysis rates of nitrapyrin in dilute aqueous solution. Arch. Environ. Contam. Toxicol., 7:149-158.

Meikle, R.W., and C.R. Youngson. 1978. The hydrolysis rate of chlorpyrifos, *O*,*O*-diethyl *O*-(3,5,6-trichloro-2-pyridyl)phosphorothioate, and its dimethyl analog, chlorpyrifos-methyl, in dilute aqueous solution. Arch. Environ. Contam. Toxicol., 7:13-22.

Melancon, M.J., Jr., and J.J. Lech. 1976. Isolation and identification of a polar metabolite of tetrachlorobiphenyl from bile of rainbow trout exposed to ^{14}C-tetrachlorobiphenyl. Bull. Environ. Contam. Toxicol., 15(2):181-188.

Melancon, M.J., Jr., D.L. Stalling, and B.T. Johnson. 1978. Metabolism of phthalate esters in aquatic species. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 56.

Menn, J.J., J.R. DeBaun, L.J. Hoffman, and J.H. Ross. 1974. Metabolism of thioaryl organophosphorus insecticides. Environ. Qual. Safety, 3(Suppl.):382-388.

Merkel, G.J., and J.J. Perry. 1977. Increased cooxidative biodegradation of malathion in soil via cosubstrate enrichment. J. Agric. Food Chem., 25(5):1011-1012.

Merrill, W., and D.W. French.
1964. The production of arsenous gases by wood-rotting fungi. Proc. Minn. Aca. of Sci., 31(2):105-106.

Meshi, T., M. Yoshikawa, and Y. Sato.
1970. Metabolic fate of bis(3,5-dichloro-2-hydroxyphenyl)sulfoxide (bithional sulfoxide). Biochem. Pharmacol., 19:1351-1361.

Metcalf, R.L., G.M. Booth, C.K. Schuth, D.J. Hansen, and P.-Y. Lu.
1973. Uptake and fate of di-2-ethylhexyl phthalate in aquatic organisms and in a model ecosystem. Environ. Hlth. Perspec., 4:27-34.

Metcalf, R.L., I.P. Kapoor, P.-Y. Lu, C.K. Schuth, and P. Sherman.
1973. Model ecosystem studies of the environmental fate of six organochlorine pesticides. Environ. Hlth. Perspec., 4:35-44.

Meyer, T.
1977. The metabolism of biphenyl. IV. Phenolic metabolites in the guinea pig and the rabbit. Acta Pharmacol. Toxicol., 40:193-200.

Meyer, T., J. Aarbakke, and R.R. Scheline.
1976a. The metabolism of biphenyl. I. Metabolic disposition of ^{14}C-biphenyl in the rat. Acta Pharmacol. Toxicol., 39:412-418.

Meyer, T., and T. Bakke.
1977. The metabolism of biphenyl. V. Phenolic metabolites in some marine organisms. Acta Pharmacol. Toxicol., 40:201-208.

Meyer, T., J.C. Larsen, E.V. Hansen, and R.R. Scheline.
1976b. The metabolism of biphenyl. III. Phenolic metabolites in the pig. Acta Pharmacol. Toxicol., 39:433-441.

Meyer, T., and R.R. Scheline.
1976. The metabolism of biphenyl. II. Phenolic metabolites in the rat. Acta Pharmacol. Toxicol., 39:419-432.

Miaullis, J.B., J.R. DeBaun, and J.J. Menn.
1976. Metabolism of *O*-ethyl *S*-4-chlorophenyl ethylphosphonodithioate (N-2596) in the rat. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 56.

Miaullis, J.B., and R.A. Gray.
1974. Metabolism of the herbicide antidote *N*,*N*-diallyl-2,2-dichloroacetamide, in the rat. Abstr. 168th ACS Meeting, Atlantic City, NJ, PEST 7.

Miaullis, J.B., L.J. Hoffman, J.R. DeBaun, and J.J. Menn.
1977a. Metabolism of *O*-ethyl *S*-4-chlorophenyl ethanephosphonodithioate (N-2596) in the rat. J. Agric. Food Chem., 25(3):501-506.

Miaullis, J.B., V.M. Thomas, R.A. Gray, J.J. Murphy, and R.M. Hollingworth.
1977b. Metabolism of R-25788 (*N*,*N*-diallyl-2,2-dichloroacetamide) in corn plants, rats and soil. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 64.

Mihara, K., and J. Miyamoto.
1974. Metabolism of Salithion (2-methoxy-4H-1,3,2-benzodioxaphosphorin-2-sulfide) in rats and plants. Agric. Biol. Chem., 38(10): 1913-1924.

Mihara, K., K. Nambu, Y. Misaki, and J. Miyamoto.
1976. Metabolism of ^{3}*H*-Cremart in rats and plants. J. Pestic. Sci., 1:207-218.

Mihara, K., Y. Okuno, Y. Misaki, and J. Miyamoto.
1978. Metabolism of fenitrothion in goats. J. Pestic. Sci., 3:233-242.

Mikami, N., H. Ohkawa, and J. Miyamoto.
1976. Photodecomposition of Surecide (*O*-ethyl *O*-4-cyanophenyl phenylphosphonothioate) and Cyanox (*O*,*O*-dimethyl *O*-4-cyanophenyl phosphorothioate). J. Pestic. Sci., 1(4):273-281.

Mikami, N., H. Ohkawa, and J. Miyamoto.
1977a. Sterospecificity in oxidation of the optical isomers of *O*-ethyl *O*-2-nitro-5-methylphenyl *N*-isopropyl phosphoramidothioate (S-2571) by liver mixed function oxidase and UV light. J. Pestic. Sci., 2(2):119-126.

Mikami, N., H. Ohkawa, and J. Miyamoto.
1977b. Photodecomposition of Salithion (2-methoxy-4*H*-1,3,2-benzodioxaphosphorin-2-sulfide) and phenthoate (*O*,*O*-dimethyl *S*-α-ethoxycarbonylbenzyl phosphorodithioate). J. Pestic. Sci., 2(3):279-290.

Millburn, P., R.L. Smith, and R.T. Williams.
1967. Biliary excretion of foreign compounds. Biphenyl, stilboestrol and phenolphthalein in the rat: molecular weight, polarity and metabolism as factors in biliary excretion. Biochem. J., 105:1275-1281.

Miller, G.C., and D.G. Crosby.
1978. Photodecomposition of sustar in water. J. Agric. Food Chem., 26(6):1316-1321.

Miller, G.C., R.G. Zepp, D.G. Crosby, and M.J. Miille.
1978. Environmental photolysis of 3,4-dichloroaniline. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 22.

Minard, R.D., S. Russel, and J.-M. Bollag.
1977. Chemical transformation of 4-chloroaniline to a triazene in a bacterial culture medium. J. Agric. Food Chem., 25(4):841-844.

Mine, A., M. Miyakado, and S. Matsunaka.
1975. The mechanism of bentazon selectivity. Pestic. Biochem. Physiol., 5:566-574.

Mingelgrin, U., Z. Gerstl, and B. Yaron.
1975. Pirimiphos ethyl-clay surface interactions. Soil Sci. Soc. Amer. Proc., 39(5):834-837.

Mio, T., K. Sumino, and T. Mizutani.
1976. Sulfur-containing metabolites of 2,5,2',5'-tetrachlorobiphenyl, a major component of commercial PCB's. Chem. Pharm. Bull., 24(8):1958-1960.

Mitchell, R.H., and P.R. West.
1978. Constituents of commercial methoxychlor (DMDT, 2,2-bis (*p*-methoxyphenyl)-1,1,1-trichloroethane). Abstr. 4th Internat. Contr. Pest. Chem. (IUPAC), Zurich, V-18.

Mitchell, S.C., and R.H. Waring.
1978. The metabolism of *cis*-2,5-dimethylpyrrolidine-1-carboxanilide in rodents. *Pestic.* Sci., 9:393-401.

Mittelstaedt, W., and F. Fuhr.
1977. Verhalten von propineb in bewachsenem und unbewachsenem boden. (The fate of propineb in planted and unplanted soil.) Landwirt. Forsch., 30(3):221-230.

Mittelstaedt, W., G.G. Still, H. Durbeck, and F. Fuhr.
1977. Extraction and identification of the major metabolite of [carbonyl-^{14}C]methabenzthiazuron after degradation in the soil. J. Agric. Food Chem., 25(4):908-912.

Miyamoto, J.
1976. Metabolism of organophosphorus insecticides in aquatic organisms. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 42.

Miyamoto, J., M.L. Keplinger, R.J. Wingender, Y. Takimoto, and D.H. Jenkins.
1977a. Residue study with cyanofenphos in milk and meat following the subacute feeding to dairy cattle. J. Pestic. Sci., 2(1):1-5.

Miyamoto, J., K. Mihara, and S. Hosokawa.
1976. Comparative metabolism of *m*-methyl-^{14}C-sumithion in several species of mammals in vivo. J. Pestic. Sci., 1(1):9-21.

Miyamoto, J., K. Mihara, T. Kadota, and Y. Okuno.
1977b. Toxicity and metabolism *in vivo* of fenitrothion in rats with experimental hepatic lesion. J. Pestic. Sci., 2:271-277.

Miyamoto, J., N. Mikami, K. Mihara, Y. Takimoto, H. Kohda, and H. Suzuki.
1978. Biological activity of fenitrothion and its degradation products. J. Pestic. Sci., 3:35-41.

Miyamoto, J., and H. Ohkawa.
1978. Oxidative processes in pesticide transformation. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-1.

Miyamoto, J., Y. Okuno, T. Kadota, and K. Mihara.
1977c. Experimental hepatic lesions and drug metabolizing enzymes in rats. J. Pestic. Sci., 2:257-269.

Miyamoto, J., A. Wakimura, and T. Kadota.
1972. Biodegradation of cyanox, *O*,*O*-dimethyl *O*-(4-cyanophenyl) phosphorothioate in rats. *Environ.* Qual. *Safety*, 1:235-239.

Miyamoto, T., and I. Yamamoto.
1977. Mechanism of phosphinyl disulfide formation from a phosphorodithioate ester. J. Pestic. Sci., 2(3):303-310.

Miyata, T., H. Honda, T. Saito, K. Ozaki, and Y. Sasaki.
1976. *In vitro* degradation of ^{14}C-methyl malathion by organophosphate susceptible and resistant smaller brown plant-hopper, *Laodelphax striatellue* Fallen. Botyu-Kagaku, 41(1):10-15.

Miyata, T., and T. Saito.
1976. Mechanism of malathion resistance in the green rice leafhopper, *Nephotettix cincticeps* Uhler (Hemiptera:Deltocephalidae). J. Pestic. Sci., 1:23-29.

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Mizutami, T.
1978. Identification of sulfur-containing metabolites of 2,4,2',4'-tetrachlorobiphenyl in mice. Bull. Environ. Contam. Toxicol., 20:219-226.

Mizutami, T., K. Yamamoto, and K. Tajima.
1978. Sulfur-containing metabolites of chlorobiphenyl isomers, a comparative study. J. Agric. Food Chem., 26(4):862-866.

Moilanen, K.W., and D.G. Crosby.
1974. Pesticide photo-oxidation in the atmosphere. 3rd IUPAC Congr. Pest. Chem. (Helsinki), Environ. Qual. Safety, 3 (Suppl.): 308-312.

Moilanen, K.W., D.G. Crosby, J.R. Humphrey, and J.W. Giles.
1976. Vapor-phase photodecomposition of fumigants. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 98.

Moilanen, K.W., D.G. Crosby, J.R. Humphrey, and J.W. Giles.
1978. Vapor-phase photodecomposition of chloropicrin (trichloronitromethane). Tetrahedron, 34:3345-3349.

Moilanen, K.W., D.G. Crosby, J.E. Woodrow, and J.N. Seiber.
1977. Vapor-phase photodecomposition of pesticides in the presence of oxidant. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 2.

Moody, R.P., R. Greenhalgh, L. Lockhart, and P. Weinberger.
1978. The fate of fenitrothion in an aquatic ecosystem. Bull. Environ. Contam. Toxicol., 19(1):8-14.

More, J.E., T.R. Roberts, and A.N. Wright.
1978. Studies of the metabolism of 3-phenoxybenzoic acid in plants. Pestic. Biochem. Physiol., 9:268-280.

Morelli, M.A., and T. Nakatsugawa.
1978. Sulfur oxyacid production as a consequence of parathion desulfuration. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 20.

Morello, A., A. Vardanis, and E.Y. Spencer.
1968. Mechanism of detoxication of some organophosphorus compounds: The role of glutathione-dependent demethylation. Can. J. Biochem., 46:885-892.

Morgan, D.P., H.L. Hetzler, E.F. Slach, and L.I. Lin.
1977. Urinary excretion of paranitrophenol and alkyl phosphates following ingestion of methyl or ethyl parathion by human subjects. Arch. Environ. Contam. Toxicol., 6:159-173.

Moribayashi, A.F., and T. Ohtaki.
1978. Inactivation of ecdysone and the possible feed back control of the titre during pupation of *Sarcophaga peregrina*. J. Insect Physiol., 24:279-284.

Morita, M., J. Nakagawa, and C. Rappe.
1978. Polychlorinated dibenzofuran (PCDF) formation from PCB mixture by heat and oxygen. Bull. Environ. Contam. Toxicol., 19(6):665-670.

Morita, M., and S. Oishi.
1975. Clearance and tissue distribution of hexachlorobenzene in rats. Bull. Environ. Contam. Toxicol., 14(3):313-318.

Moriya, S., and Y. Maeda.
1976. Penetration and metabolism of substituted phenyl methylcarbamates in green rice leafhopper, *Nephotettix cincticeps* Uhler. Japan J. Appl. Entomol. Zool., 20(4):198-202.

Morton, D.M., and D.G. Hoffman.
1976. Metabolism of a new herbicide tebuthiuron 1-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-1,3-dimethylurea in mouse, rat, rabbit, dog, duck and fish. J. Toxicol. Environ. Hlth., 1:757-768.

Morton, T.C., G. Holan, and C.T.F. Virgona.
1976. Metabolism of 1,1-bis-(*p*-ethoxyphenyl)-2-nitropropane in the house fly and the cluster caterpillar. Pestic. Biochem. Physiol., 6:209-214.

Moshier, L.J., and D. Penner.
1978. Factors influencing microbial degradation of ^{14}C-glyphosate to $^{14}CO_2$ in soil. Weed Sci., 26(6):686-691.

Mostafa, I., P. Moza, I. Weisgerber, und W. Klein.
1974. Beitrage zur okologischen chemie LXX. Orientierende versuche zum lindan-metabolismus hoherer pflanzen in hydrokultur. Chemosphere, 3(2):55-58.

Motooka, P.S.
1973. Uptake, translocation and metabolism of Sandoz 6706 in soybean and sicklepod. Dissert. Abstr., 34B(6):2414.

Motooka, P.S., F.T. Corbin, and A.D. Worsham.
1977. Metabolism of Sandoz 6706 in soybean and sicklepod. Weed Sci., 25(1):9-12.

Motoyama, N., and W.C. Dauterman.
1974. The role of nonoxidative metabolism in organophosphorus resistance. J. Agric. Food Chem., 22(3):350-356.

Motoyama, N., and W.C. Dauterman.
1975. Interstrain comparison of glutathione-dependent reactions in susceptible and resistant houseflies. Pestic. Biochem. Physiol., 5:489-495.

Motoyama, N., and W.C. Dauterman.
1977. Purification and properties of housefly glutathione *S*-transferase. Insect Biochem., 7:361-369.

Motoyama, N., and W.C. Dauterman.
1978. Multiple forms of rat liver glutathione *S*-transferases: Specificity for conjugation of *O*-alkyl and *O*-aryl groups of organophosphorus insecticides. J. Agric. Food Chem., 26(6): 1296-1301.

Motoyama, N., W.C. Dauterman, and F.W. Plapp, Jr.
1977. Genetic studies on glutathione-dependent reactions in resistant strains of the house fly, *Musca domestica* L. Pestic. Biochem. Physiol., 7:443-450.

Mottley, J., and R.C. Kirkwood.
1978. The uptake, translocation and metabolism of dichlobenil in selected aquatic species. Weed Res., 18:187-198.

Mourik, J., and L.P.A. de Jong.
1978. Binding of the organophosphates parathion and paraoxon to bovine and human serum albumin. Arch. Toxicol., 41:43-48.

Moza, P.N.
1976. Unpublished, in Viswanathan et al., 1976.

Moza, P., L. Kilzer, I. Weisgerber, and W. Klein.
1976a. Contributions to ecological chemistry CXV: Metabolism of 2,5,4'-trichlorobiphenyl-^{14}C and 2,4,6,2',4'-pentachlorobiphenyl-^{14}C in the marsh plant Veronica beccabunga. Bull. Environ. Contam. Toxicol., 16(4):454-463.

Moza, P., I. Mostafa, und W. Klein.
1974. Beitrage zur okologischen chemie LXXXIX. Orientierende versuche zum metabolismus von γ-pentachlorocyclohex-l-en in hoheren pflanzen in hydrokultur. Chemosphere, 3(6):255-258.

Moza, P., I. Weisgerber, and W. Klein.
1976b. Fate of 2,2'-dichlorobiphenyl-^{14}C in carrots, sugar beets, and soil under outdoor conditions. J. Agric. Food Chem., 24(4): 881-885.

Muecke, W., R.E. Menzer, K.O. Alt, W. Richter, and H.O. Esser.
1976. The metabolism of chlorotoluron in the rat. Pestic. Biochem. Physiol., 6(5):430-441.

Muir, D.C., and B.E. Baker.
1976. Detection of triazine herbicides and their degradation products in tile-drain water from fields under intensive corn (maize) production. J. Agric. Food Chem., 24(1):122-125.

Muir, D.C.G., and B.E. Baker.
1978. The disappearance and movement of three triazine herbicides and several of their degradation products in soil under field conditions. Weed Res., 18:111-120.

Muir, D.C.G., and N. Grift.
1978. Disappearance of the experimental aquatic herbicide fluridone (EL-171) in small ponds. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 58.

Muller, H., and W. Schuphan.
1975. A contribution to the application of the plant-growth regulator chlorocholine chloride (CCC) in vegetable crops. 2. Biochemical studies in the metabolism of CCC in kohlrabi, cauliflower, and tomatoes. Qual. Plant.-Pl. Fds. Hum. Nutr. XXV, 2:171-186.

Muller, W.F., I. Scheunert, K. Rozman, W. Kogel, D. Freitag, E. Richter, F. Coulston, and F. Korte.
1978. Comparative metabolism of hexachlorobenzene and pentachloronitrobenzene in plants, rats, and rhesus monkeys. Ecotoxicol. Environ. Safety, 2:437-445.

Munnecke, D.M., and D.P.H. Hsieh.
1975. Microbial metabolism of a parathion-xylene pesticide formulation. Appl. Microbiol., 30(4):575-580.

Munnecke, D.M., and D.P.H. Hsieh.
1976. Pathways of microbial metabolism of parathion. Appl. Environ. Microbiol., 31(1):63-69.

Munnecke, D.M., and B.J. Moore.
1975. Inactivation of methylmercury dicyandiamide by *Penicillium* in soil and the relationship to damping-off of peas. *Pestic. Sci.*, 6:620-638.

Murai, T.
1977. Photodecomposition of *O*-ethyl *S*,*S*-diphenyl phosphorodithiolate (edifenphos). Agric. Biol. Chem., 41(1):71-77.

Murai, T.
1978. Photolysis of organophosphorus fungicides. JARQ, 12(4): 194-197.

Murai, T., and H. Igawa.
1977. Photodecomposition of *S*-benzyl *O*,*O*-diisopropyl phosphorothiolate (Kitazin P). Agric. Biol. Chem., 41(5):803-809.

Murai, T., and C. Tomizawa.
1976. Chemical transformation of *S*-benzyl *O*-ethyl phenylphosphonothiolate (Inezin) by ultraviolet light. J. Environ. Sci. Hlth., B11(2):185-197.

Murthy, N.B.K., and D.D. Kaufman.
1977a. Anaerobic soil degradation of pentachlorophenol (PCP). Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 36.

Murthy, N.B.K., and D.D. Kaufman.
1977b. Degradation of pentachloronitrobenzene (PCNB) in anaerobic soils. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 37.

Murthy, N.B., and D.D. Kaufman.
1978. Degradation of pentachloronitrobenzene (PCNB) in anaerobic soils. J. Agric. Food Chem., 26(5):1151-1156.

Murthy, N.B.K., P.C. Kearney, J.E. Oliver, and W. Lusby.
1977. Anaerobic metabolism of toxaphene fractions in soil. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 40.

Myatt, G.L., and D.J. Ecobichon.
1975. Fenitrooxon and *S*-methyl fenitrothion: Acute toxicity and hydrolysis in mammals. Environ. Res., 10:407-414.

Nadkarni, M.V., E.I. Goldenthal, and P.K. Smith.
1957. The distribution of radioactivity following administration of triethylenephosphoramide-P^{32} in tumor-bearing and control mice. Cancer Res., 17:97-101.

Nadkarni, M.V., E.G. Trams, and P.K. Smith.
1959. Preliminary studies on the distribution and fate of TEM, TEPA, and myleran in the human. Cancer Res., 19:713-718.

Nakagawa, M., and M. Ando.
1977. Metabolism of credazine, 3-(2'-methylphenoxy)pyridazine, in rats. Agric. Biol. Chem., 41(10):1975-1984.

Nakagawa, M., and D.G. Crosby.
1974a. Photodecomposition of nitrofen. J. Agric. Food Chem., 22(5):849-853.

Nakagawa, M., and D.G. Crosby.
1974b. Photonucleophilic reactions of nitrofen. J. Agric. Food Chem., 22(6):930-933.

Nakagawa, M., K. Kawakubo, and M. Ishida.
1971. Metabolism of the herbicide 3-(2'-methylphenoxy)pyridazine in plants. Agric. Biol. Chem., 35(5):764-777.

Nakajima, M., T. Fujita, N. Kurihara, Y. Sanemitsu, M. Uchida, and M. Kiso.
1974. Insecticidal activity and biodegradability of lindane analogs. Environ. Qual. Safety, 3(Suppl.):370-376.

Nakajima, S., N. Naito, and T. Tani.
1973. Microbial transformation of 2,4-D and its analogues. Chem. Pharm. Bull., 21(3):671-673.

Nakamura, T., K. Yamaoka, and T. Saito.
1977. Studies on persistence of isoxathion. I. Residue determination of isoxathion and its oxygen analog and preliminary studies on persistence of isoxathion in crops and soils. Botyu-Kagaku, 42(1):32-40.

Nakamura, Y., K. Ishikawa, and S. Kuwatsuka.
1977a. Degradation of benthiocarb in soils as affected by soil conditions. J. Pestic. Sci., 2(1):7-16.

Nakamura, Y., K. Ishikawa, and S. Kuwatsuka.
1977b. Metabolic fate of benthiocarb herbicide in plants. Agric. Biol. Chem., 41(9):1613-1620.

Nakayama, Y., S. Nonomura, and C. Tatsumi.
1973. The metabolism of coumarin by a strain of *Pseudomonas*. Agric. Biol. Chem., 37(6):1423-1437.

Nakazawa, T., and E. Hayashi.
1978. Phthalate and 4-hydroxyphthalate metabolism in *Pseudomonas testosteroni*: Purification and properties of 4,5-dihydroxyphthalate decarboxylase. Appl. Environ. Microbiol., 36(2): 264-269.

Narang, S.S.
1972. Induced photolysis of alkyl halides. Dissert. Abstr., 33B(2):603.

Nash, R.G.
1976. Uptake of ethylenebis(dithiocarbamate) fungicides and ethylenethiourea by soybeans. J. Agric. Food Chem., 24(3):596-601.

Nehez, M., A. Paldy, and A. Selypes.
1977. Some data on the decomposition of dinitro-o-cresol by microorganisms. Acta Phytopathol. Acad. Sci. Hung., 12(1-2): 73-79.

Neiderhiser, D.H., R.K. Fuller, L.J. Hejduk, and H.P. Roth.
1976. Method for the detection of diethylamine, a metabolite of disulfiram, in urine. J. Chromatography, 117:187-192.

Nelson, J.O., and P.C. Kearney.
1977. Metabolism of maleic hydrazide (MH) by hepatic microsomes from phenobarbital induced rats. Bull. Environ. Contam. Toxicol., 17(1):108-111.

Nelson, J.O., P.C. Kearney, J.R. Plimmer, and R.E. Menzer.
1976a. Metabolism of three dinitroaniline herbicides by rat liver microsomes. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 59.

Nelson, J.O., P.C. Kearney, J.R. Plimmer, and R.E. Menzer.
1977a. Metabolism of trifluralin, profluralin, and fluchloralin by rat liver microsomes. Pestic. Biochem. Physiol., 7:73-82.

Nelson, J.O., R.E. Menzer, P.C. Kearney, and J.R. Plimmer.
1977b. 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin: *In vitro* binding to rat liver microsomes. Bull. Environ. Contam. Toxicol., 18(1):9-13.

Nelson, P.A., R.R. Stewart, M.A. Morelli, and T. Nakatsugawa.
1976b. Aldrin epoxidation in the earthworm, *Lumbricus terrestris* L. Pestic. Biochem. Physiol., 6:243-253.

Neu, H.J., and K. Ballschmiter.
1977. Abbau von chlorierten aromaten: Mikrobiologischer abbau der polychlorierten biphenyle (PCB) II. Biphenylole als metabolite der PCB. Chemosphere, 6(7):419-423.

Newhall, W.F., and B.S. Buslig.
1977. An analytical procedure for determining residues of the quaternary ammonium plant regulator AMCHEM Z-2088. J. Agric. Food Chem., 25(1):198-200.

Newsome, W.H.
1976. Residues of four ethylenebis(dithiocarbamates) and their decomposition products on field-sprayed tomatoes. J. Agric. Food Chem., 24(5):999-1001.

Niki, Y., and S. Kuwatsuka.
1976a. Degradation of diphenyl ether herbicides in soils. Soil Sci. Plant Nutr., 22(3):223-232.

Niki, Y., and S. Kuwatsuka.
1976b. Degradation products of chlomethoxynil (X-52) in soil. Soil Sci. Plant Nutr., 22(3):233-245.

Niki, Y., S. Kuwatsuka, and I. Yokomichi.
1976. Absorption, translocation and metabolism of chlomethoxynil (X-52) in plants. Agric. Biol. Chem., 40(4):683-690.

Nilles, G.P., and M.J. Zabik.
1975. Photochemistry of bioactive compounds. Multiphase photodegradation and mass spectral analysis of basagran. J. Agric. Food Chem., 23(3):410-415.

Niwa, Y., T. Miyata, and T. Saito.
1977. *In vitro* metabolism of malathion by malathion resistant and susceptible strains of houseflies, *Musca domestica* L. J. Pestic. Sci., 2:151-157.

Noguchi, T., Y. Hashimoto, and H. Miyata.
1968. Studies of the biochemical lesions caused by a new fluorine pesticide, *N*-methyl-*N*-(1-naphthol)monofluoroacetamide. Toxicol. Appl. Pharmacol., 13:189-198.

Nomeir, A.A., and W.C. Dauterman.
1978. In vitro degradation of malathion by mouse liver. Biochem. Pharmacol., 27:2975-2976.

Nomura, N.S., and H.W. Hilton.
1977. The adsorption and degradation of glyphosate in five Hawaiian sugarcane soils. Weed Res., 17:113-121.

Norback, D.H., J.L. Seymour, K.M. Knieriem, R.E. Peterson, and J.R. Allen.
1976. Biliary metabolites of 2,5,2',5'-tetrachlorobiphenyl in the rat. Res. Commun. Chem. Path. Pharm., 14(3):527-533.

Nordgren, I., M. Bergstrom, B. Holmstedt, and M. Sandoz.
1978. Transformation and action of metrifonate. Arch. Toxicol., 41:31-41.

Norpoth, J.K., J. Knippschild, U. Witting, and H.M. Rauen.
1972. Oxidation of cyclophosphamide by means of $KMNO_4$. Experientia, 28:536-537.

Norpoth, K., and H.M. Rauen.
1972. Stoffwechselwege des cyclophosphamids. Klin. Wschr., 50:449-453.

Norris, F.A., and G.A. Still.
1974. Liberation of the bound residues from 3,4-dichloroaniline-^{14}C treated rice root tissues. Abstr. 168th ACS Meeting, Atlantic City, NJ, PEST 45.

Norris, L.A., M.L. Montgomery, and E.R. Johnson.
1977. The persistence of 2,4,5-T in a Pacific Northwest forest. Weed Sci., 25(5):417-422.

Norstrom, A., K. Andersson, and C. Rappe.
1976. Formation of chlorodibenzofurans by irradiation of chlorinated diphenyl ethers. Chemosphere, 5(1):21-24.

Norstrom, A., K. Andersson, and C. Rappe.
1977. Studies on the formation of chlorodibenzofurans by irradiation or pyrolysis of chlorinated diphenyl ethers. Chemosphere, 6(5):241-248.

Norstrom, R.J., R.W. Risebrough, and D.J. Cartwright.
1976. Elimination of chlorinated dibenzofurans associated with polychlorinated biphenyls fed to mallards (Anas platyrhynchos). Toxicol. Appl. Pharmacol., 37:217-228.

Nutahara, M., and M. Yamamoto.
1978. Decomposition of residual captafol in homogenized preparations of fruits and vegetables. J. Pestic. Sci., 3:101-107.

Nye, D.E., H.E. Hurst, and H.W. Dorough.
1976. Fate of Croneton (2-ethylthiomethylphenyl N-methylcarbamate) in rats. J. Agric. Food Chem., 24(2):371-377.

Odanaka, Y., Y. Kabasawa, K. Takahashi, O. Matano, and S. Goto.
1978a. Metabolic fate of ferric methanearsonate (MAF) in rat. J. Pestic. Sci., 3(2):109-118.

Odanaka, Y., O. Matano, and S. Goto.
1978b. Identification of dimethylated arsenic by gas chromatography-mass spectrometry in blood, urine, and feces of rats treated with ferric methanearsonate. J. Agric. Food Chem., 26(2):505-507.

Oeser, H., S. Gorbach, and E. Boerner.
1974. Translocation and metabolism of pyracarbolid in wheat. Environ. Qual. Safety, 3(Suppl.):557-561.

Ogata, H., E. Saito, H. Murato, T. Shibazaki, and T. Inoue.
1976. Stability of *O,O*-dimethyl 2,2-dichlorovinyl phosphate in oil preparation. Yakugaku Zasshi (J. Pharm. Soc. Japan), 96(4):434-439.

Ogawa, J.M., E. Bose, B.T. Manji, E.R. White, and W.W. Kilgore.
1971. Biological activity of conversion products of benomyl. Phytopathology, 61:905.

Ogawa, K., H. Aizawa, and F. Yamauchi.
1978. Fates of fluoroimide [(4-fluorophenyl)-2,3-dichloromaleimide, Spartcide] in plant and soils. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-509.

Ogawa, K., M. Tsuda, F. Yamauchi, I. Yamaguchi, and T. Misato.
1976. Metabolism of 2-*sec*-butylphenyl *N*-methylcarbamate (Bassa, BPMC) in rice plants and its degradation in soils. J. Pestic. Sci., 1:219-229.

Ogawa, K., M. Tsuda, F. Yamauchi, I. Yamaguchi, and T. Misato.
1977. Metabolism of 2-*iso*-propylphenyl *N*-methylcarbamate (Mipcin, MIPC) in rice plants and its degradation in soils. J. Pestic. Sci., 2:51-57.

Ohisa, N., and M. Yamaguchi.
1978a. Gamma BHC degradation accompanied by the growth of *Clostridium rectum* isolated from paddy field soil. Agric. Biol. Chem., 42(10):1819-1823.

Ohisa, N., and M. Yamaguchi.
1978b. Degradation of gamma-BHC in flooded soils enriched with peptone. Agric. Biol. Chem., 42(11):1983-1987.

Ohkawa, H., Y. Hisada, N. Fujiwara, and J. Miyamoto.
1974a. Metabolism of *N*-(3',5'-dichlorophenyl)succinimide in rats and dogs. Agric. Biol. Chem., 38(7):1359-1369.

Ohkawa, H., H. Kaneko, and J. Miyamoto.
1977a. Metabolism of permethrin in bean plants. J. Pestic. Sci., 2(1):67-76.

Ohkawa, H., N. Mikami, and J. Miyamoto.
1976a. Sterospecific metabolism of *O*-ethyl *O*-2-nitro-5-methylphenyl *N*-isopropyl phosphoramidothioate (S-2571) by liver microsomal mixed function oxidase. Agric. Biol. Chem., 40(10):2125-2127.

Ohkawa, H., N. Mikami, and J. Miyamoto.
1977b. Stereoselectivity in metabolism of the optical isomers of cyanofenphos (*O*-*p*-cyanophenyl *O*-ethyl phenylphosphonothioate) in rats and liver microsomes. Agric. Biol. Chem., 41(2):369-376.

Ohkawa, H., N. Mikami, and J. Miyamoto.
1978a. Metabolism of the optical isomers of cyanofenphos in rice stem borer larvae. Agric. Biol. Chem., 42(2):445-450.

Ohkawa, H., K. Nambu, H. Inui, and J. Miyamoto.
1978b. Metabolic fate of fenvalerate (Sumicidin) in soil and by soil microorganisms. J. Pestic. Sci., 3:129-141.

Ohkawa, H., Y. Okihara, and J. Miyamoto.
1976b. Metabolism of the fungicide Denmert (*S*-*n*-butyl *S*'-*p*-*tert*-butyl-benzyl *N*-3-pyridyldithiocarbonimidate, S-1358) and Denmert sulfoxides in liver enzyme systems. Agric. Biol. Chem., 40(6): 1175-1182.

Ohkawa, H., H. Oshita, and J. Miyamoto.
1978c. Reactivation and aging of α-chymotrypsin inhibited by the chiral isomers of EPN-oxon and saligenin cyclic phosphoryl compounds. Agric. Biol. Chem., 42(9):1745-1751.

Ohkawa, H., R. Shibaike, Y. Okihara, M. Morikawa, and J. Miyamoto.
1976c. Degradation of the fungicide Denmert (*S*-*n*-butyl *S*'-*p*-*tert*-butylbenzyl *N*-3-pyridyldithiocarbonimidate, S-1358) by plants, soils and light. Agric. Biol. Chem., 40(5):943-951.

Ohkawa, H., R. Yoshihara, T. Kohara, and J. Miyamoto.
1974b. Metabolism of *m*-tolyl *N*-methylcarbamate(Tsumacide) in rats, houseflies and bean plants. Agric. Biol. Chem., 38(5):1035-1044.

Ohsawa, K., and J.E. Casida.
1978. Photochemistry of the potent knockdown pyrethroid Kadethrin. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 53.

Ohta, T., R.J. Kuhr, and W.S. Bowers.
1977. Radiosynthesis and metabolism of the insect antijuvenile hormone, precocene II. J. Agric. Food Chem., 25(3):478-481.

Ohyama, H., and S. Kuwatsuka.
1978a. Fate and behaviors of phenothiol, S-ethyl 4-chloro-*o*-tolyloxythioacetate, in soils, rice plants and rats. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-511.

Ohyama, H., and S. Kuwatsuka.
1978b. Degradation of bifenox, a diphenyl ether herbicide, methyl 5-(2,4-dichlorophenoxy)-2-nitrobenzoate, in soils. J. Pestic. Sci., 3:401-410.

Okada, S., and O. Tamemasa.
1978. Distribution and metabolism of di-(*n*-butyl)-phthalate in mice and its interaction with nucleic acids and proteins. Yakugaku Zasshi, 98(9):1229-1235.

Oliver, J.E., and A. Kontson.
1978. Formation and persistence of *N*-nitrosobutralin in soil. Bull. Environ. Contam. Toxicol., 20:170-173.

Olson, B.H., and R.C. Cooper.
1976. Comparison of aerobic and anaerobic methylation of mercuric chloride by San Francisco Bay sediments. Water Res., 10:113-116.

Olson, K.R., K.S. Squibb, and R.J. Cousins.
1978. Tissue uptake, subcellular distribution, and metabolism of $^{14}\mathrm{CH_3HgCl}$ and $\mathrm{CH_3{}^{203}HgCl}$ by rainbow trout, *Salmo gairdneri*. J. Fish. Res. Board Can., 35:381-390.

Olson, L.E., J.L. Allen, and J.W. Hogan.
1977. Biotransformation and elimination of the herbicide dinitramine in carp. J. Agric. Food Chem., 25(3):554-556.

Olson, L.E., J.L. Allen, and W.L. Mauck.
1975. Dinitramine: Residues in and toxicity to freshwater fish. J. Agric. Food Chem., 23(3):437-439.

Omata, S., K. Sakimura, T. Ishii, and H. Sugano.
1978. Chemical nature of a methylmercury complex with a low molecular weight in the liver cytosol of rats exposed to methylmercury chloride. Biochem. Pharmacol., 27:1700-1701.

Oppenoorth, F.J., and S. Voerman.
1975. Hydrolysis of paraoxon and malaoxon in three strains of *Myzus persicae* with different degrees of parathion resistance. Pestic. Biochem. Physiol., 5:431-443.

Osicka-Koprowska, A., B. Wysocka-Paruszewska, D. Witkowska, and Z. Czech.
1978. Wydalanie *p*-nitro-*m*-krezolu i zmiany aktywnosci esterazy acetylocholinowej u szczurow zatruwanych fenitrotionem. (Excretion of *p*-nitro-*m*-cresol and changes of acetylcholinesterase activity in rats intoxicated with fenitrothion.) Bromat. Chem. Toksykol., 11:151-157.

Osteryoung, J., J. Whittaker, J. Tessari, and V. Boyes.
1976. The identification of *p*-nitroaniline as a metabolite of the rodenticide *Vacor* in human liver. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 94.

Oswald, T.H. A.E. Smith, and D.V. Phillips.
1978. Phytotoxicity and detoxification of metribuzin in dark-grown suspension cultures of soybean. Pestic. Biochem. Physiol., 8:73-83.

Otto, S.
1974. Degradation and metabolism of fluchloralin in soil. Environ. Qual. Safety, 3(Suppl.):277-281.

Otto, S., P. Beutel, N. Drescher, and R. Huber.
1978. Investigations into the degradation of bentazon in plant and soil. 4th Internat. Congr. Pest. Chem., Zurich, in *Advances in Pesticide Science*, ed. H. Geissbuhler, Permagon Press, Part 3, Pages 551-556.

Ou, L.T., and H.C. Sikka.
1977. Extensive degradation of silvex by synergistic action of aquatic microorganisms. J. Agric. Food Chem., 25(6): 1336-1339.

Owen, R.B., Jr., J.B. Dimond, and A.S. Getchell.
1977. DDT: Persistence in northern spodosols. J. Environ. Qual., 6(4):359-360.

Padmanabhan, U., and D.J. Wort.
1977. Metabolism and distribution of cyclohexanecarboxylic acid, a plant growth stimulant, in bush bean. Plant Physiol., 60:22-25.

Pape, B.E.
1975. Photochemistry of bioactive compounds. I. Solution-phase photochemistry of asymmetric triazin-5-(4H)-ones. II. Solution-phase photochemistry of symmetrical triazines. Dissert. Abstr., 36B(3):1058.

Paris, D.F., and D.L. Lewis.
1974a. Rates and products of degradation of malathion by bacteria and fungi from aquatic environments. Abstr. 167th ACS Meeting, Los Angeles, CA, PEST 64.

Paris, D.F., and D.L. Lewis.
1974b. Rates and products of degradation of malathion by bacteria and fungi from aquatic systems. Environ. Qual. Safety, 3(Suppl.): 288-291.

Paris, D.F., D.L. Lewis, and N.L. Wolfe.
1975. Rates of degradation of malathion by bacteria isolated from aquatic systems. Environ. Sci. Technol., 9(2):135-138.

Parish, J.C., and B.W. Arthur.
1965. Mammalian and insect metabolism of the chemosterilant thiotepa. J. Econ. Entomol., 58(4):976-979.

Parlar, H.
1978. Umwandlung einiger cyclodieninsektizide auf blattoberflachen durch einwirkung von sonnenlicht. Chemosphere, 7(9): 721-728.

Parlar, H., S. Gab, S. Nitz, and F. Korte.
1976. Beitrage zur okologischen chemie CXXVII. Zur photochemie des toxaphens: Reaktionen von chlorierten bornanderivaten in losung und adsorbiert an kieselgel. Chemosphere, 5:333-338.

Parlar, H., and M. Mansour.
1978. On the sensitized photoisomerization reaction of the insecticide β-dihydroheptachlor. J. Agric. Food Chem., 26(4): 984-986.

Parlar, H., M. Mansour, and R. Baumann.
1978. Photoreactions of hydroxychlordene in solution, as solids, and on the surface of leaves. Agric. Food Chem., 26(6):1321-1324.

Parmar, B.S., S.Y. Pandey, and S.K. Mukerjee.
1976. Photodegradable formulations of DDT. Experientia, 32: 279-280.

Parochetti, J.V., and G.W. Dec, Jr.
1978. Photodecomposition of eleven dinitroaniline herbicides. Weed Sci., 26(2):153-156.

Parr, J.F., and S. Smith.
1976. Degradation of toxaphene in selected anaerobic soil environments. Soil Sci., 121(1):52-57.

Paschal, D.C., and M.E. Neville.
1976. Chemical and microbial degradation of malaoxon in an Illinois soil. J. Environ. Qual., 5(4):441-443.

Patil, T.N., and R. Radhakrishnamurty.
1977. Distribution and excretion of α-napthylthio-[^{14}C]urea in albino rats. Indian J. Biochem. Biophys., 14:275-279.

Paulson, G.D., A.M. Jacobsen, and G.G. Still.
1975. Animal metabolism of propham (isopropyl carbanilate): The fate of residues in alfalfa when consumed by the rat and sheep. Pestic. Biochem. Physiol., 5:523-535.

Paulson, G.D., A.M. Jacobsen, and R.G. Zaylskie.
1977. Herbicide perfluidone (1,1,1-trifluoro-*N*-[2-methyl-4-(phenylsulfonyl)phenyl]methanesulfonamide): Its metabolism in rats and chickens. Pestic. Biochem. Physiol., 7:62-72.

Pease, H.L., and R.F. Holt.
1977. Manganese ethylenebis(dithiocarbamate) (maneb)/ethylenethiourea (ETU) residue studies on five crops treated with ethylenebis(dithiocarbamate) (EBDC) fungicides. J. Agric. Food Chem., 25(3):561-567.

Peeper, T.F., and J.B. Weber.
1976. Movement of VEL 5026 in soil leaching columns and runoff studies. Abstr. Weed Sci. Soc. Amer., 87-88.

Peeples, A., and R.R. Dalvi.
1978. Toxicologic studies of *N*-trichloromethylthio-4-cyclohexene-1,2-dicarboximide (captan): Its metabolism by rat liver drug-metabolizing enzyme system. Toxicology, 9:341-351.

Pekas, J.C., J.E. Bakke, J.L. Giles, and C.E. Price.
1977. Rat intestinal metabolism of crufomate (4-*tert*-butyl-2-chlorophenyl methyl methylphosphoramidate). J. Environ. Sci. Hlth., B12(4):261-268.

Pennacchioni, A., R. Marchetti, and G.F. Gaggino.
1976. Inability of fish to methylate mercuric chloride *in vivo*. J. Environ. Qual., 5(4):451-454.

Penrose, W.R.
1975. Biosynthesis of organic arsenic compounds in brown trout (*Salmo trutta*). J. Fish Res. Bd. Canada, 32(12):2385-2390.

Penrose, W.R., H.B.S. Conacher, R. Black, J.C. Meranger, W. Miles, H.M. Cunningham, and W.R. Squires.
1977. Implications of inorganic/organic interconversion on fluxes of arsenic in marine food webs. Environ. Hlth. Perspec., 19:53-59.

Pentreath, R.J.
1976a. The accumulation of inorganic mercury from sea water by the plaice, *Pleuronectes platessa* L. J. Exp. Mar. Biol. Ecol., 24:103-119.

Pentreath, R.J.
1976b. The accumulation of organic mercury from sea water by the plaice, *Pleuronectes platessa* L. J. Exp. Mar. Biol. Ecol., 24:121-132.

Peterson, C.A., and L.V. Edgington.
1970. Transport of the systemic fungicide, benomyl, in bean plants. Phytopathology, 60:475-478.

Peterson, C.A., and L.V. Edgington.
1971. Transport of benomyl into various plant organs. Phytopathology, 61:91-92.

Petrella, V.J., J.P. Fox, and R.E. Webb.
1975. Endrin metabolism in endrin-susceptible and -resistant strains of pine mice. Toxicol. Appl. Pharmacol., 34:283-291.

Petrella, V.J., J.D. McKinney, J.P. Fox, and R.E. Webb.
1977. Identification of metabolites of endrin. Metabolism in endrin susceptible and resistant strains of pine mice. J. Agric. Food Chem., 25(2):393-398.

Pfeilsticker, K., und I.R. Siddiqui.
1976. Isolierung der durch athylenoxyd-1,2^{14}C derivatisierten inhaltsstoffe aus kakao und ihre massenspektrometrisch ermittelte struktur. Z. Lebensm. Unters.-Forsch., 160:19-27.

Phillips, S.E., and M.L. Taylor.
1976. Oxidation of arsenite to arsenate by *Alcaligenes faecalis*. Appl. Environ. Microbiol., 32(3):392-399.

Pieper, G.R., and C.E. Richmond.
1976. Residues of trichlorfon and lauroyl trichlorfon in Douglas-fir, willow, grass, aspen foliage, and in creek water after aerial application. Bull. Environ. Contam. Toxicol., 15(2):250-256.

Pierce, R.H., Jr., and D.M. Victor.
1977. The fate of pentachlorophenol in an aquatic ecosystem. Presented at the Symposium on Pentachlorophenol, Pensacola Beach, FL., June 27-29.

Pik, A.J., E. Peake, M.T. Strosher, and G.W. Hodgson.
1977. Fate of 3,6-dichloropicolinic acid in soils. J. Agric. Food Chem., 25(5):1054-1061.

Pillai, C., G. Parthasarathy, J.D. Weete, and D.E. Davis.
1977a. Metabolism of atrazine by *Spartina alterniflora*. I. Chloro-form-soluble metabolites. J. Agric. Food Chem., 25(4): 852-855.

Pillai, M.K., K. Agarwal, and D.V. Yadav.
1977b. Tolerance, uptake and metabolism of DDT in *Gambusia affinis*. Indian J. Exp. Biol., 15:40-41.

Piller, N.B.
1977. Tissue levels of (3-^{14}C)coumarin in the rat: Distribution and excretion. Br. J. Exp. Pathol., 58:28-34.

Pilson, M.E.Q.
1974. Arsenate uptake and reduction by *Pocillopora verrucosa*. Limnol. Oceanog., 19:339-341.

Plapp, F.W., W.S. Bigley, G.A. Chapman, and G.W. Eddy.
1962. Metabolism of methaphoxide in mosquitoes, house flies, and mice. J. Econ. Entomol., 55(5):607-613.

Plapp, F.W., Jr., W.S. Bigley, and D.I. Darrow.
1960. Studies on the metabolism and residues of P^{32}-labeled delnav in a hereford steer. J. Econ. Entomol., 53(1):60-64.

Plimmer, J.R.
1978. Photolysis of TCDD and trifluralin on silica and soil. Bull. Environ. Contam. Toxicol., 20:87-92.

Plimmer, J.R., and U.I. Klingebiel.
1976. Photolysis of hexachlorobenzene. J. Agric. Food Chem., 24(4):721-723.

Pohl, L.R., R. Bales, and W.F. Trager.
1976. Warfarin: Stereochemical aspects of its metabolism *in vivo* in the rat. Res. Commun. Chem. Path. Pharm., 15(2):233-256.

Pohl, L.R., S.D. Nelson, W.A. Garland, and W.F. Trager.
1975. The rapid identification of a new metabolite of warfarin via a chemical ionization mass spectrometry ion doublet technique. Biomed. Mass Spectro., 2:23-30.

Pollero, R., and S.C. Pollero.
1978. Degradation of DDT by a soil amoeba. Bull. Environ. Contam. Toxicol., 19(3):345-350.

Pool, J.F.A.
1912. De biologische arseenreactie met monilia sitophila saccardo. Pharm. Weekblad., 49:878-886.

Portig, J., S. Sodomann, and K. Stein.
1975. On the biotransformation in rats of hexachlorocyclohexane. Proc. 6th Internat. Cong. Pharmacol. (Helsinki) Abstr. No. 50.

Pree, D.J., K.P. Butler, E.R. Kimball, and D.K.R. Stewart.
1976. Persistence of foliar residues of dimethoate and azinphosmethyl and their toxicity to the apple maggot. J. Econ. Entomol., 69(4):473-478.

Pree, D.J., and D.K.R. Stewart.
1975. Persistence in water of formulations of the insect development inhibitor ZR515. Bull. Environ. Contam. Toxicol., 14(1): 117-121.

Pressman, D., and H.L. Lucas.
1942. Hydration of unsaturated compounds. XI. Acrolein and acrylic acid. J. Amer. Chem. Soc., 64:1953-1959.

Prester, D., I. Weisgerber, W. Klein, und F. Korte.
1976. Beitrage zur okologischen chemie CXXI. Bilanz der verteilung und umwandlung von metribuzin-^{14}C (Sencor) in kartoffeln, mohren und boden unter freilandbedingungen. Chemosphere, 5(2):137-144.

Price, T.V., and M.V. Carter.
1975. Persistence of benomyl in pruned apricot sapwood. Aust. J. Agric. Res., 26:529-536.

Priest, B., and R.J. Stephens.
1975. Studies on the breakdown of *p*-chlorophenyl methylcarbamate. I. In soil. Pestic. Sci., 6:53-59.

Pritchard, J.B.
1972. Metabolism of DDT and its relation to persistence in the winter flounder. Fed. Proc., 31:605.

Pritchard, J.B., A.M. Guarino, and W.B. Kinter.
1973. Distribution, metabolism, and excretion of DDT and mirex by a marine teleost, the winter flounder. Environ. Hlth. Perspec., 4:45-54.

Pruitt, G.W., B.J. Grantham, and R.H. Pierce, Jr.
1977. Accumulation and elimination of pentachlorophenol by the bluegill, *Lepomis macrochirus*. Trans. Amer. Fish. Soc., 106(5):462-465.

Puech, A.A.
1974. Translocation and metabolism of 2-chloroethylphosphonic acid (Ethephon), and its influence on pigments during the ripening of fig, *Ficus carica* L., fruits. Dissert. Abstr., 35(4):1477-1478.

Puntoni, V.
1917. Arsenioschizomiceti. Annali d'Igiene, 27:293-303.

Putnam, A.R.
1976. Fate of glyphosate in deciduous fruit trees. Weed Sci., 24(4):425-430.

Quistad, G.B., D.A. Schooley, L.E. Staiger, B.J. Bergot, B.H. Sleight, and K.J. Macek.
1976a. Environmental degradation of the insect growth regulator methoprene. IX. Metabolism by bluegill fish. Pestic. Biochem. Physiol., 6:523-529.

Quistad, G.B., L.E. Staiger, B.J. Bergot, and D.A. Schooley.
1975a. Environmental degradation of the insect growth regulator methoprene. VII. Bovine metabolism to cholesterol and related natural products. J. Agric. Food Chem., 23(4):743-749.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1974. Environmental degradation of the insect growth regulator methoprene (isopropyl(*2E,4E*)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate). I. Metabolism by alfalfa and rice. J. Agric. Food Chem., 22(4):582-589.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1975b. Environmental degradation of the insect growth regulator methoprene (isopropyl(*2E,4E*)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate). III. Photodecomposition. J. Agric. Food Chem., 23(2):299-303.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1975c. Environmental degradation of the insect growth regulator methoprene. VIII. Bovine metabolism to natural products in milk and blood. J. Agric. Food Chem., 23(4):750-753.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1975d. Environmental degradation of the insect growth regulator methoprene. V. Metabolism by houseflies and mosquitoes. Pestic. Biochem. Physiol., 5:233-241.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1976b. Environmental degradation of the insect growth regulator methoprene. X. Chicken metabolism. J. Agric. Food Chem., 24(3): 644-648.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1976c. Cholesterol and bile acids via acetate from the insect juvenile hormone analog methoprene. Life Sci., 15:1797-1804.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1977. The comparative metabolism of the miticide cycloprate (hexadecyl cyclopropanecarboxylate). Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 53.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1978a. Environmental degradation of the miticide cycloprate (hexadecyl cyclopropanecarboxylate). 1. Rat metabolism. J. Agric. Food Chem., 26(1):60-66.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1978b. Environmental degradation of the miticide cycloprate. 2. Metabolism by apple and oranges. J. Agric. Food Chem., 26(1):66-70.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1978c. Environmental degradation of the miticide cycloprate (hexadecyl cyclopropanecarboxylate). 3. Bovine metabolism. J. Agric. Food Chem., 26(1):71-75.

Quistad, G.B., L.E. Staiger, and D.A. Schooley.
1978d. Environmental degradation of the miticide cycloprate (hexadecyl cyclopropanecarboxylate). 4. Beagle dog metabolism. J. Agric. Food Chem., 26(1):76-80.

Raef, S.F., W.G. Characklis, M.A. Kessick, and C.H. Ward.
1977a. Fate of cyanide and related compounds in aerobic microbial systems - I. Chemical reaction with substrate and physical removal. Water Res., 11:477-483.

Raef, S.F., W.G. Characklis, M.A. Kessick, and C.H. Ward.
1977b. Fate of cyanide and related compounds in aerobic microbial systems - II. Microbial degradation. Water Res., 11:485-492.

Rahn, P.R., and R.L. Zimdahl.
1973. Soil degradation of two phenyl pyridazinone herbicides. Abstr. Weed. Sci. Soc. Amer., 56.

Rajaram, K.P., and N. Sethunathan.
1975. Effect of organic sources on the degradation of parathion in flooded alluvial soil. Soil Sci., 119(4):296-300.

Rappe, C., S. Marklund, H.R. Buser, and H.-P. Bosshardt.
1978. Formation of polychlorinated dibenzo-*p*-dioxins (PCDDs) and dibenzofurans (PCDFs) by burning or heating chlorophenates. Chemosphere, 7(3):269-281.

Rash, J.J., and M.J. Lynch.
1976. Metabolism of 2-[3-chloro-4-(4-chlorobenzoyl)phenyl]-*as*-triazine-3,5(2H,4H)-dione by the chicken. Drug Metab. Dispos., 4(1):59-64.

Rast, H.G. G. Engelhardt, P.R. Wallnofer, L. Oehlmann, and K. Wagner.
1978. Microbial metabolism of methylthio-substituted phenols as degradation products of thioaryl organophosphorus insecticides in soil. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-501.

Rauen, H.M., E. Golovinsky, and N. Norpoth.
1968. Pharmacobiochemistry of endoxan. Suvremenna Meditsina, 19:106-110.

Rauen, H.M., und K. Norpoth.
1967. Hochspannungselektrophoretische untersuchungen an metaboliten des N,N-bis(2-chlorathyl)-N',O-propylenphosphorsaureester-diamids aus dem serum der ratte. Arzneim.-Forsch., 17:599-602.

Reddy, G., and M.A.Q. Khan.
1976. Metabolism of [^{14}C]photoisodrin in mice and houseflies. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 57.

Reddy, G., and M.A.Q. Khan.
1977a. Metabolism of [^{14}C]photodieldrin in houseflies. J. Agric. Food Chem., 25(1):25-28.

Reddy, G., and M.A.Q. Khan.
1977b. Metabolism of [^{14}C]photoisodrin in mice and houseflies. Gen. Pharmacol., 8:285-289.

Reddy, G., and M.A.Q. Khan.
1978. Urinary metabolites of [^{14}C]photodieldrin in male rabbits. J. Agric. Food Chem., 26(1):292-294.

Redemann, C.T., R.W. Meikle, and J.G. Widofsky.
1964. The loss of 2-chloro-6-(trichloromethyl)-pyridine from soil. J. Agric. Food Chem., 12(3):207-209.

Reed, D.L., P.B. Bush, N.H. Booth, J.T. Kiker, D.D. Goetsch, and R.L. Farrell.
1977. Tissue residues from feeding pentachloronitrobenzene to broiler chickens. Toxicol. Appl. Pharmacol., 42:433-441.

Refsvik, T.
1978. Excretion of methyl mercury in rat bile: The effect of diethylmaleate, cyclohexene oxide and acrylamide. Acta Pharmacol. Toxicol., 42:135-141.

Reichert, W.L., and D.C. Malins.
1974. Interaction of mercurials with salmon serum lipoproteins. Nature, 247(5442):569-570.

Reif, V.D., J.E. Sinsheimer, J.C. Ward, and D.E. Schteingart.
1974. Aromatic hydroxylation and alkyl oxidation in metabolism of mitotane (o,p'-DDT) in humans. J. Pharm. Sci., 63:1730-1736.

Renerre, M.P., G.F. Bories, and J.C. Rougeot.
1975. Cyclophosphamide-^{14}C metabolism in the angora rabbit. J. Animal Sci., 41(3):825-828.

Renner, G., E. Richter, and K.P. Schuster.
1978a. N-Acetyl-S-(pentachlorophenyl)cysteine, a new urinary metabolite of hexachlorobenzene. Chemosphere, 7(8):663-668.

Renner, G., and K.P. Schuster.
1977. 2,4,5-Trichlorophenol, a new urinary metabolite of hexachlorobenzene. Toxicol. Appl. Pharmacol., 39:355-356.

Renner, G., K.P. Schuster, H.B. Kuhnhen, und H.-D. Stachel.
1978b. Isolierung von stoffwechselprodukten der pestizide hexachlorbenzol und pentachlor-nitrobenzol aus harn und faeces von ratten und kaninchen. Chemosphere, 7(12):943-947.

Respicio, N.C.
1976. Toxicological and biochemical transformation capacities in gypsy moth, *Porthetria dispar* (Linn.), larvae. Dissert. Abstr. 36B(10):4843-4844.

Reynolds, P.J., I.L. Lindahl, H.C. Cecil, and J. Bitman.
1976. A comparison of DDT and methoxychlor accumulation and depletion in sheep. Bull. Environ. Contam. Toxicol., 16(2):240-247.

Rho, E.M., and W.C. Evans.
1975. The aerobic metabolism of cyclohexanecarboxylic acid by *Acinetobacter anitratum*. Biochem. J., 148:11-15.

Rhodes, R.C.
1977a. Studies with manganese [^{14}C]ethylenebis(dithiocarbamate) ([^{14}C]maneb) fungicide and [^{14}C]ethylenethiourea ([^{14}C]ETU) in plants, soil, and water. J. Agric. Food Chem., 25(3):528-533.

Rhodes, R.C.
1977b. Metabolism of [2-^{14}C]terbacil in alfalfa. J. Agric. Food Chem., 25(5):1066-1068.

Richey, F.A., Jr., W.J. Bartley, and K.P. Sheets.
1977. Laboratory studies on the degradation of (the pesticide) aldicarb in soils. J. Agric. Food Chem., 25(1):47-51.

Rickard, R.W., and N.D. Camper.
1978. Degradation of fluometuron by *Rhizoctonia solani*. Pestic. Biochem. Physiol., 9:183-189.

Riden, J.R., and W.J. Asbell.
1974. The fate of Protect (1,8-naphthalic anhydride) in corn plants. Environ. Qual. Safety, 3(Suppl.):175-179.

Ripley, B.D., and D.F. Cox.
1978. Residues of ethylenebis(dithiocarbamate) and ethylenethiourea in treated tomatoes and commerical tomato products. J. Agric. Food Chem., 26(5):1137-1143.

Ripley, B.D., D.F. Cox, J. Wiebe, and R. Frank.
1978. Residues of Dikar and ethylenethiourea in treated grapes and commercial grape products. J. Agric. Food Chem., 26(1):134-136.

Ripley, B.D., and C.M. Simpson.
1977. Residues of zineb and ethylene thiourea in orchard treated pears and commercial pear products. Pestic. Sci., 8:487-491.

Riviere, J.E., et J. Fernandez.
1978. Le metabolisme de detoxication chez *Prodenia litura* (Lep., Noctuidae): l'aldrine epoxydase. *Ann. Zool. Ecol. anim.*, 10(2):281-287.

Roberts, R.B., M. Look, W.F. Haddon, and T.C. Dickerson.
1978. A new degradation product of the insecticide mexacarbate found in fresh water. J. Agric. Food Chem., 26(1):55-59.

Roberts, T.R.
1977a. The metabolism of the herbicide flamprop-isopropyl in barley. Pestic. Biochem. Physiol., 7:378-390.

Roberts, T.R
1977b. The metabolism of the herbicide flamprop-methyl in wheat. Pestic. Sci., 8:463-472.

Roberts, T.R., and M.E. Standen.
1977a. Degradation of the pyrethroid cypermethrin NRDC 149 (±)-α-cyano-3-phenoxybenzyl (±)-*cis*,*trans*-3-(2,2-dichlorvinyl)-2,2-dimethylcyclopropanecarboxylate and the respective *cis*-(NRDC 160) and *trans*-(NRDC 159) isomers in soils. Pestic. Sci., 8:305-319.

Roberts, T.R., and M.E. Standen.
1977b. Degradation of the pyrethroid insecticide WL 41706, (±)-α-cyano-3-phenoxybenzyl 2,2,3,3-tetramethylcyclopropanecarboxylate, in soils. Pestic. Sci., 8:600-610.

Roberts, T.R., and M.E. Standen.
1978. Degradation of the herbicide flamprop-methyl in soil under anaerobic conditions. Pestic. Biochem. Physiol., 9:322-333.

Roberts, T.R., and G. Stoydin.
1976a. Metabolism of the insecticide SD 8280, 2-chloro-1-(2,4-dichlorophenyl)vinyl dimethyl phosphate, following its application to rice. Pestic. Sci., 7:135-144.

Roberts, T.R., and G. Stoydin.
1976b. Degradation of the insecticide SD 8280, 2-chloro-1-(2,4-dichlorophenyl)vinyl dimethyl phosphate, in soils. Pestic. Sci., 7:145-149.

Roberts, T.R., and G. Stoydin.
1976c. The degradation of (Z)- and (E)-1,3-dichloropropenes and 1,2-dichloropropane in soil. Pestic. Sci., 7:325-335.

Robinson, B.H., and F.M. Fisher.
1978. Carbamate metabolism: Conjugation. Abstr. 176th ACS Meeting, Miami Beach, FL, PEST 80.

Robinson, D.E., and D.W. Greene.
1976. Metabolism and differential susceptibility of crabgrass and witchgrass to simazine and atrazine. Weed Sci., 24(5):500-504.

Robinson, E.L.
1975. Arsenic in soil with five annual applications of MSMA. Weed Sci., 23(5):341-343.

Robinson, K.M., and J.D. Yarbrough.
1978a. A study of liver function in rats with mirex-induced enlarged livers. Pestic. Biochem. Physiol., 9:61-64.

Robinson, K.M., and J.D. Yarbrough.
1978b. Liver response to oral administration of mirex in rats. Pestic. Biochem. Physiol., 8:65-72.

Robocker, W.C., and B.A. Zamora.
1976. Translocation and metabolism of dicamba in western bracken. Weed Sci., 24(4):435-438.

Rodriquez, L.D., and H.W. Dorough.
1977. Degradation of carbaryl by soil microorganisms. Arch. Environ. Contam. Toxicol., 6:47-56.

Rogers, R.D.
1976. Methylation of mercury in agricultural soils. J. Environ. Qual., 5(4):454-458.

Rogers, R.D.
1977. Abiological methylation of mercury in soil. J. Environ. Qual., 6(4):463-467.

Rogers, R.D.
1977. Abiological methylation of mercury in soil. EPA-600/3-77-007, 11 pages.

Rogers, R.L.
1973. Behavior of H^3-SAN-9789 in soil and in cotton plants. Abstr. Weed Sci. Soc. Amer., 57.

Rose, J.Q., J.C. Ramsey, T.H. Wentzler, R.A. Hummel, and P.J. Gehring.
1976. The fate of 2,3,7,8-tetrachlorodibenzo-p-dioxin following single and repeated oral doses to the rat. Toxicol. Appl. Pharmacol., 36:209-226.

Rosenblum, C., D.J. Tocco, and E.E. Howe.
1964. Complications in residue studies with radioisotope drugs. In: Proc. 2nd Ann. Oak Ridge Radioisotope Conf., Gatlinburg, TN, pp. 58-62, April 19-22.

Rosival, L., M. Vargova, J. Szokolayova, and K. Cerey.
1976. Contribution to the toxic action of S-methyl fenitrothion. Pestic. Biochem. Physiol., 6:280-286.

Rouchaud, J.P., J.R. Decallonne, and J.A. Meyer.
1977a. Metabolism of the fungicide triforine in barley plants. Pestic. Sci., 8:65-70.

Rouchaud, J.P., J.R. Decallonne, and J.A. Meyer.
1977b. Metabolism of 2-aminobenzimidazole and benzimidazole in melon plants. Pestic. Sci., 8:31-34.

Rouchaud, J.P., J.R. Decallonne, and J.A. Meyer.
1977c. Residues of triforine and its metabolites in barley grain and straw. Bull. Environ. Contam. Toxicol., 18(6):742-748.

Rouchaud, J., J.R. Decallonne, and J.A. Meyer.
1978a. The nature of bound residues derived from triforine in barley plants. Pestic. Sci., 9:74-78.

Rouchaud, J., J.R. Decallonne, and J.A. Meyer.
1978b. Metabolism of [2,5-^{14}C]piperazine in barley plants. Pestic. Sci., 9:139-145.

Rouchaud, J., J.R. Decallonne, and J.A. Meyer.
1978c. Metabolism of 2,5-[^{14}C]-piperazine in barley plants. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-526.

Rouchaud, J.P., G.J. Lhoest, M.J. Mercier, and J.A. Meyer.
1977d. Metabolism of benomyl in carrot, strawberry and apple. Pestic. Sci., 8:23-30.

Rouchaud, J., C. Moons, J.R. Decallonne, and J.A. Meyer.
1978d. Photodecomposition of piperazine in water by 'sunlight' ultraviolet radiation. Pestic. Sci., 9:305-309.

Rouchaud, J., C. Moons, J.R. Decallonne, and J.A. Meyer.
1978e. Metabolism of [^{3}H]triforine in barley grown in the field: The unbound radioactive residue. Pestic. Sci., 9:578-594.

Rowland, I., M. Davies, and P. Grasso.
1977. Biosynthesis of methylmercury compounds by the intestinal flora of the rat. Arch. Environ. Hlth., 32(1):24-28.

Rowland, I.R., M.J. Davies, and P. Grasso.
1978. Metabolism of methylmercuric chloride by the gastrointestinal flora of the rat. Xenobiotica, 8(1):37-43.

Rowland, I.R., P. Grasso, and M.J. Davies.
1975. The methylation of mercuric chloride by human intestinal bacteria. Experientia, 31:1064.

Rowlands, D.G.
1976. The uptake and metabolism by stored wheat grains of an insect juvenile hormone and two insect hormone mimics. J. Stored Prod. Res., 12:35-41.

Rowlands, D.G., and J.S. Bramhall.
1977. The uptake and translocation of malathion by the stored wheat grain. J. Stored Prod. res., 13:13-22.

Ruddick, J.A., W.H. Newsome, and F. Iverson.
1977. A comparison of the distribution, metabolism and excretion of ethylenethiourea in the pregnant mouse and rat. Teratology, 16(2):159-162.

Ruddick, J.A., D.T. Williams, L. Hierlihy, and K.S. Khera.
1975. [C]Ethylenethiourea: Distribution, excretion, and metabolism in pregnant rats. Teratology, 13:35-40.

Rueppel, M.L., B.B. Brightwell, J. Schaefer, and J.T. Marvel.
1977. Metabolism and degradation of glyphosate in soil and water. J. Agric. Food Chem., 25(3):517-528.

Rueppel, M.L., and J.T. Marvel.
1975. The spectral characterization of *N*-phosphonomethylglycine and its soil metabolites by ^{1}H, ^{31}P, ^{13}C-NMR and GC/MS. Abstr. 170th ACS Meeting, Chicago, IL, PEST 25.

Rueppel, M.L., J.T. Marvel, and B.B. Brightwell.
1975a. The metabolism and dissipation of *N* phosphonomethylglycine in soil and water. Abstr. 170th ACS Meeting, Chicago, IL, PEST 24.

Rueppel, M.L., J.T. Marvel, and L.A. Suba.
1975b. The metabolism of *N*-phosphonomethylglycine in corn, cotton, soybeans, and wheat. Abstr. 170th ACS Meeting, Chicago, IL, PEST 26.

Rueppel, M.L., J.T. Marvel, and L.A. Suba.
1975c. The characterization of *N*-phosphonomethylglycine and its plant metabolites by NMR derivatization, GC/MS/COM, and isotopic dilution techniques. Abstr. 170th ACS Meeting, Chicago, IL, PEST 27.

Runnels, J.M., and M.A.Q. Khan.
1973. Hepatic mixed-function oxidase activity toward cyclodiene insecticides in the domestic pigeon. Amer. Zool., 13:1308-1309.

Ruothula, M., and J.K. Miettinen.
1975. Retention and excretion of ^{203}Hg-labelled methylmercury in rainbow trout. Oikos, 26:385-390.

Rusness, D.G., and G.G. Still.
1977a. Partial purification and properties of *S*-cysteinyl-hydroxychlorpropham transferase from oat (*Avena sativa* L.). Pestic. Biochem. Physiol., 7:220-231.

Rusness, D.G., and G.G. Still.
1977b. *S*-Cysteinyl-hydroxychlorpropham transferase inhibition by chlorpropham analogs, sulfhydryl compounds, *ortho*- and/or *para*-substituted phenols, and firefly luciferin. Pestic. Biochem. Physiol., 7:232-241.

Ruzo, L.O., R.L. Holmstead, and J.E. Casida.
1977a. Pyrethroid photochemistry: Decamethrin. J. Agric. Food Chem., 25(6):1385-1394.

Ruzo, L.O., G. Sundstrom, O. Hutzinger and S. Safe.
1976. Photodegradation of polybromobiphenyls (PBB). J. Agric. Food Chem., 24(5):1062-1065.

Ruzo, L.O., T. Unai, and J.E. Casida.
1977b. Pyrethroid metabolism: Decamethrin. Abstr. 174th ACS Meeting, Chicago, IL, PEST 25.

Ruzo, L.O., T. Unai, and J.E. Casida.
1978. Decamethrin metabolism in rats. J. Agric. Food Chem., 26(4):918-925.

Sadasivam, K.V.
1974. Cyanide-tolerant microorganisms in the rizosphere of tapioca. Soil. Biol. Biochem., 6:203.

Safe, S., and D. Jones, and O. Hutzinger.
1976. Metabolism of 4,4'-dihalogenobiphenyls. J. Chem. Soc., Perkin Trans. I, 357-359.

Safe, S., J. Kohli, and A. Crawford.
1978. Fire Master BP-6: Fractionation, metabolic and enzyme induction studies. Environ. Hlth. Perspec., 23:147-152.

Safe, S., L.O. Ruzo, D. Jones, N.S. Platonow, and O. Hutzinger.
1975. The metabolism of 4-chlorobiphenyl in the pig. Can. J. Physiol. Pharmacol., 53:392-396.

Saha, J.G., and R.H. Burrage.
1976. Residues of lindane and its metabolites in eggs, chicks, and body tissues of hen pheasants after ingestion of lindane-^{14}C via treated wheat seed or gelatin capsules. J. Environ. Sci. Hlth., B11(1):67-93.

Sakriss, W., S. Gab, and F. Korte.
1976. Beitrage zur okologischen chemie CXXVIII. Photooxidationsreaktionen von methabenzthiazuron in losung. Chemosphere, 5:339-348.

Saleh, M.A., and J.E. Casida.
1978a. Approaches to the metabolic and environmental degradation of toxaphene. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 4.

Saleh, M.A., and J.E. Casida.
1978b. Metabolism of toxaphene and its components. 4th International Congr. Pest. Chem. (IUPAC) Zurich, V-8.

Saleh, M.A., and J.E. Casida.
1978c. Reductive dechlorination of the toxaphene component 2,2,5-*endo*,6-*exo*,8,9,10-heptachlorobornane in various chemical, photochemical, and metabolic systems. J. Agric. Food Chem., 26(3):583-590.

Saleh, M.A., W.V. Turner, and J.E. Casida.
1977. Polychlorobornane components of toxaphene: Structure-toxicity relations and metabolic reductive dechlorination. Science, 198:1256-1258.

Saltzman, S., U. Mingelgrin, and B. Yaron.
1976. Role of water in the hydrolysis of parathion and methylparathion on kaolinite. J. Agric. Food Chem., 24(4):739-743.

Sams, G.R., G.F. Cocchiaro, and W.J. Bell.
1978. Metabolism of juvenile hormone in cultures of ovaries and fat body in the cockroach *Periplaneta americana*. In Vitro, 14(11):956-960.

Sanborn, J.R., W.F. Childers, and L.G. Hanse .
1977a. Uptake and elimination of [^{14}C]hexachlorobenzene (HCB) by the green sunfish, *Lepomis cyanellus* Raf., after feeding contaminated food. J. Agric. Food Chem., 25(3):551-553.

Sanborn, J.R., R.L. Metcalf, W.N. Bruce, and P.-Y. Lu.
1976. The fate of chlordane and toxaphene in a terrestrial-aquatic model ecosystem. Environ. Entomol., 5(3):533-538.

Sanborn, J.R., R.L. Metcalf, and L.G. Hansen.
1977b. The neurotoxicity of *O*-(2,5-dichlorophenyl) *O*-methyl phenylphosphonothionate, an impurity and photoproduct of leptophos (Phosvel) insecticide. Pestic. Biochem. Physiol., 7:142-145.

Sanburg, L.L., K.L. Kramer, F.J. Kezdy, and J.H. Law.
1975. Juvenile hormone-specific esterases in the haemolymph of the tobacco hornworm, *Manduca sexta*. J. Insect Physiol., 21:873-887.

Sandberg, C.L.
1978. Herbicidal efficacy and physiological aspects of glyphosate [*N*-(phosphonomethyl)glycine] on field bindweed (*Convolvulus arvensis* L.). Dissert. Abstr., 39B(3):1074-1075.

Sandberg, C.L., W.F. Meggitt, and D. Penner.
1978. Metabolism of ^{14}C-glyphosate by tall morningglory [*Ipomoea purpurea* (L.) Roth.], Canada thistle [*Cirsium arvense* (L.) Scop.], and field bindweed (*Convolvulus arvensis* L.). Abstr. Weed Sci. Soc. Amer., 74.

Sanger, C.R.
1894. On the formation of volatile compounds of arsenic from arsenical wall papers. Proc. Amer. Acad. Arts and Sci. (New Series 21) Whole Series 29:112-147.

Santi, R., and F. Gozzo.
1976. Degradation and metabolism of drepamon in rice and barnyard grass. J. Agric. Food Chem., 24(6):1229-1235.

Saravanja-Bozante, V., S. Gab, K. Hustert, and F. Korte.
1977. Beitrage zur okologischen chemie CXXXIII. Reaktionen von aldrin, chlorden und 2,2'-dichlorbiphenyl mit O(3P). Chemosphere, 6(1):21-26.

Sauber, K., F. Blobel, S. Haug, and J. Eberspacher.
1976. On the enzymatics of the microbial breakdown of pyrazone. Zbl. Bakt. Hyg. I. 162B:149-152.

Sauerhoff, M.W., W.H. Braun, G.E. Blau, and P.J. Gehring.
1976a. The dose-dependent pharmacokinetic profile of 2,4,5-trichlorophenoxy acetic acid following intravenous administration to rats. Toxicol. Appl. Pharmacol., 36:491-501.

Sauerhoff, M.W., W.H. Braun, G.E. Blau, and P.J. Gehring.
1977a. The fate of 2,4-dichlorophenoxyacetic acid (2,4-D) following oral administration to man. Toxicol., 8:3-11.

Sauerhoff, M.W., M.B. Chenoweth, R.J. Karbowski, W.H. Braun, J.C. Ramsey, P.J. Gehring, and G.E. Blau.
1977b. Fate of silvex following oral administration to humans. J. Toxicol. Environ. Hlth., 3:941-952.

Sauerhoff, M.W., J.P. Heeschen, R.A. Nyquish, and W.H. Braun.
1976b. Pharmacokinetic profile of diamidfos in rats. Food Cosmet. Toxicol., 14:401-408.

Saunders, J.L., and L.W. Getzin.
1973. Distribution of phorate and its oxidation analogues in Scots pine. J. Econ. Entomol., 66(2):530-531.

Savage, K.E.
1973. Nitralin and trifluralin persistence in soil. Weed Sci., 21(4):285-288.

Savage, K.E.
1977. Metribuzin persistence in soil. Weed Sci., 25(1):55-59.

Savage, K.E.
1978. Persistence of several dinitroaniline herbicides as affected by soil moisture. Weed Sci., 26(5):465-471.

Sayler, G.S., R. Thomas, and R.R. Colwell.
1978. Polychlorinated biphenyl (PCB) degrading bacteria and PCB in estuarine and marine environments. Estuar. Coastal Mar. Sci., 6:553-567.

Scales, E.H., and J.D. Yarbrough.
1975. Endrin uptake in insecticide-resistant and susceptible mosquitofish (Gambusia affinis). J. Agric. Food Chem., 23(6): 1076-1079.

Schaefer, C.H., and E.F. Dupras.
1976. Factors affecting the stability of dimilin in water and the persistence of dimilin in field waters. J. Agric. Food Chem., 24(4):733-739.

Schaefer, C.H., E.F. Dupras, Jr., R.J. Stewart, L.W. Davidson, and A.E. Colwell.
1979. The accumulation and elimination of diflubenzuron by fish. Bull. Environ. Contam. Toxicol., 21:249-254.

Schaumloffel, V.E., und V. Wetzel.
1978. Tierexperimentelle untersuchungen uber die reaktivitat stabiler metabolite des cyclophosphamid *in vivo*. Arzneim.-Forsch., 28(1):378-386.

Scheunert, I., J. Kohli, R. Kaul, and W. Klein.
1977. Fate of $[^{14}C]$ aldrin in crop rotation under outdoor conditions. Ecotoxicol. Environ. Safety, 1:365-385.

Schiller, J.G., and A.E. Chung.
1970. The metabolism of cyclopropanecarboxylic acid. J. Biol. Chem., 245(21):5857-5864.

Schimmel, S.C., J.M. Patrick, Jr., and J. Forester.
1976a. Heptachlor: Toxicity to and uptake by several estuarine organisms. J. Toxicol. Environ. Hlth., 1:955-965.

Schimmel, S.C., J.M. Patrick, Jr., and J. Forester.
1976b. Heptachlor: Uptake, depuration, retention and metabolism by spot, *Leiostomus xanthurus*. J. Toxicol. Environ. Hlth., 2: 169-178.

Schimmel, S.C., J.M. Patrick, Jr., and J. Forester.
1977. Toxicity and bioconcentration of BHC and lindane in selected estuarine animals. Arch. Environ. Contam. Toxicol., 6:355-363.

Schooley, D.A., B.J. Bergot, L.L. Dunham, and J.B. Sidda.
1975a. Environmental degradation of the insect growth regulator methoprene (isopropyl (*2E*,*4E*)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate). II. Metabolism by aquatic microorganisms. J. Agric. Food Chem., 23(2):293-298.

Schooley, D.A., K.M. Creswell, L.E. Staiger, and G.B. Quistad.
1975b. Environmental degradation of the insect growth regulator isopropyl (2E,4E)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate (methoprene). IV. Soil metabolism. J. Agric. Food Chem., 23(3): 369-373.

Schooley, D.A., G.B. Quistad, and L.E. Staiger.
1978. Cyclopropanecarboxylic acid: Chain elongation to ω-cyclopropyl fatty acids by mammals and plants. Science, 199:544-545.

Schottel, J.L.
1978. The mercuric and organomercurial detoxifying enxymes from a plasmid-bearing strain of *Escherichia coli*. J. Biol. Chem., 253(12):4341-4349.

Schrauzer, G.N., and R.N. Katz.
1978. Reductive dechlorination and degradation of mirex and kepone with vitamin B_{12s}. Bioinorg. Chem., 9:123-143.

Schuler, W., und W. Merbach.
1978. Untersuchungen uber das verhalten von CCC (2Ochlorathyltrimethylammoniumchlorid) in weizenmehl wahrend des backprozesses. Die Nahrung, 22(1):41-48.

Schultz, D.P., and P.D. Harman.
1978. Hydrolysis and photolysis of the lampricide 2',5-dichloro-4'-nitrosalicylanilide (Bayer 73). Invest. Fish Cont. No. 85, USDI, FWS, 5 p.

Schulz, K.R., T.W. Fuhremann, and E.P. Lichtenstein.
1976. Interaction of pesticide chemicals. Effect of eptam and its antidote on the uptake and metabolism of [^{14}C]phorate in corn plants. J. Agric. Food Chem., 24(2):296-299.

Schumacher, R.W.
1974. Metabolism of metribuzin in soybeans and soil. Dissert. Abstr., 35B(4):1485.

Schumacher, R.W., L. Thompson, Jr., and C.E. Rieck.
1974. Metribuzin metabolism in soybeans. Abstr. Weed Sci. Soc. Amer., 123-124.

Schuntner, C.A., and P.G. Thompson.
1978. Metabolism of [^{14}C]amitraz in larvae of Boophilus microplus. Aust. J. Biol. Sci., 31:141-148.

Schuphan, I., and W. Ebing.
1975. Zum metabolismus von phenylharnstoff-herbiziden. V. Metabolismus von hydroxyliertem monolinuron in spinat. Chemosphere, 5(4):307-310.

Schuphan, I., and W. Ebing.
1977. Zum metabolismus von phenylharnstoff-herbiziden. VII. Metabolismusaufklarung und bilanzierung des verbleibs von buturon-^{14}C nach anwendung bei winterweizen. (Metabolism of phenylurea herbicides. VII. Metabolism studies and balance of the fate of buturon-^{14}C after application to wheat). Weed Res., 17:181-189.

Schuphan, I., and W. Ebing.
1978. Metabolism and balance studies of [^{14}C]monolinuron after use in spinach followed by cress and potato cultures. Pestic. Biochem. Physiol., 9:107-118.

Schuth, C.K., A.R. Isensee, E.A. Woolson, and P.C. Kearney.
1974. Distribution of ^{14}C and arsenic derived from [^{14}C]cacodylic acid in an aquatic ecosystem. J. Agric. Food Chem., 22(6):999-1003.

Schweizer, E.E.
1976. Persistence and movement of ethofumesate in soil. Weed Res., 16:37-42.

Seiber, J.N., M.P. Catahan, and C.R. Barril.
1978. Loss of carbofuran from rice paddy water: Chemical and physical factors. J. Environ. Sci. Hlth., B12(2): 131-148.

Seidler, H., M. Hartig, W. Schnaak, and R. Engst.
1971. Untersuchungen uber den metabolismus einiger insektizide und fungizide in der ratte. 3. Mitt.: Ausscheidung, verteilung und abbau von ^{35}S-markiertem captan. Die Nahrung, 15(2):177-185.

Seifert, J., C. Blattny, H. Henzlerova, and J. Davidek.
1978. Persistence of fungicide euparen on strawberry and/or in some canned products of strawberry. Bull. Environ. Contam. Toxicol., 20:702-706.

Seifert, J., and J. Davidek.
1977. The interaction of folpet with thiamine and two thiamine-dependent systems. Pestic. Biochem. Physiol., 7:56-61.

Sekizawa, Y., K. Umemura, M. Shimura, A. Suzuki, and T. Kikuchi.
1975. Residue analyses on 2-amino-4-phenythiazole, a piscine anesthetic, in fishes--I. A model radiotracer experiment with medaka. Bull. Jap. Soc. Sci. Fish., 41(4):449-458.

Selim, S., and R.F. Cook.
1978. Residue determination of a dioxane herbicide in soil and soybeans by high-pressure liquid chromatography. J. Agric. Food Chem., 26(1):106-110.

Selim, S., R.F. Cook, and B.C. Leppert.
1977. Determination of residues of karbutilate and its major metabolites in water, soil, and grass by high-pressure liquid chromatography. J. Agric. Food Chem., 25(3):567-572.

Severson, J.G., Jr., B.A. Bohm, and C.E. Seaforth.
1970. The metabolism of cyclohexanecarboxylic acid in *Phaseolus vulgaris*. Phytochem., 9:107-110.

Seymour, J.L., S.P. Schmidt, and J.R. Allen.
1976. In vitro generation of a chemically reactive metabolite of 2,5,2',5'-tetrachlorobiphenyl by rhesus monkey liver microsomes. Proc. Soc. Exptl. Biol. Med., 152:621-625.

Shannon, L.R.
1977. Equilibrium between uptake and elimination of dieldrin by channel catfish, *Ictalurus punctatus*. Bull. Environ. Contam. Toxicol., 17(3):278-284.

Sharma, M.P. W.H. Vanden Born, H.A. Friesen, and D.K. McBeath.
1976. Penetration, translocation and metabolism of ^{14}C-difenzoquat in wild oat and barley. Weed Sci., 24(4):379-384.

Sharom, M.S., and G.R. Stephenson.
1976. Behavior and fate of metribuzin in eight Ontario soils. Weed Sci., 24(2):153-160.

Sharpee, K.W.
1973. Microbial degradation of phenoxy herbicides in culture, soil, and aquatic ecosystems. Dissert. Abstr., 34B(3):954.

Sheela, S., and V.N. Vasantharajan.
1977. Persistence of fensulfothion in soil. J. Environ. Sci. Hlth., B12(1):15-35.

Shida, T., Y. Homma, and T. Misato.
1973. Bacterial degradation of *N*-lauroyl-l-valine. Agric. Biol. Chem., 37(5):1027-1033.

Shida, T., Y. Homma, A. Kamimura, and T. Misato.
1975a. Degradation of *N*-lauroyl-L-valine in soil and the effect of sunlight and ultraviolet rays on *N*-lauroyl-l-valine. Agric. Biol. Chem., 39(4):879-883.

Shida, T., Y. Homma, and T. Misato.
1975b. Absorption, translocation, and degradation of *N*-lauroyl-l-valine in plants (studies on the control of plant diseases by amino acid derivatives part VI). J. Agric. Chem. Soc. Japan, 49(8):409-415.

Shimabukuro, R.H., G.L. Lamoureux, and D.S. Frear.
1977. Glutathione conjugation: A mechanism for herbicide detoxication and selectivity in plants. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 69.

Shimabukuro, R.H., G.L. Lamoureux, D.S. Frear, H.R. Swanson, W.C. Walsh, and L.E. Stafford.
1973. Fluorodifen metabolism by glutathione conjugation in higher plants. Abstr. Weed Sci. Soc. Amer., 63.

Shimabukuro, R.H., W.C. Walsh, G.E. Stolzenberg, and P.A. Olson.
1976. Metabolsim of fluorodifen to *S*-(2-nitro-4-trifluoromethylphenyl)-*N*-malonyl-cysteine in peanut. Abstr. Weed Sci. Soc. Amer., 81-82.

Shimada, T.
1976. Metabolic activation of $[^{14}\mathrm{C}]$polychlorinated mixtures by rat liver microsomes. Bull. Environ. Contam., 16(1):25-32.

Shimotori, H., and S. Kuwatsuka.
1978. Absorption, translocation and metabolism of CNP, a diphenyl ether herbicide, and its amino derivative in rice plants. J. Pestic. Sci., 3:267-275.

Shimura, M., and Y. Sekizawa.
1975. Residue analyses on 2-amino-4-phenylthiazole, a piscine anesthetic, in fishes II. Resolution on chemical structure of the metabolite in medaka. Bull. Jap. Soc. Sci. Fish. 41(5):529-534.

Shipp, E., and J. Otton.
1976. Diel changes in DDT absorption and breakdown rates and respiratory rhythm in the housefly, *Musca domestica*. Entomol. Exp. Appl., 19:235-242.

Shirai, R.
1977. Study on cyanide metabolism in loquat by radioisotope tracer method and isotope dilution method. J. Agric. Chem. Soc. Japan, 51(9):531-534.

Shirai, R., K. Hirota, and T. Sakaguchi.
1977. Partial purification of cyanide metabolizing activity in mesocarp of loquat. J. Agric. Chem. Soc. Japan, 51(9):527-530.

Shono, T., and J.E. Casida.
1978. Species-specificity in enzymatic oxidation of pyrethroid insecticides: 3-phenoxybenzyl and α-cyano-3-phenoxybenzyl 3-(2,2-dihalovinyl)-2,2-dimethylcyclopropanecarboxylates. J. Pestic. Sci., 3:165-168.

Shono, T., T. Unai, and J.E. Casida.
1978. Metabolism of permethrin isomers in American cockroach adults, house fly adults, and cabbage looper larvae. Pestic. Biochem. Physiol., 9:96-106.

Shrivastava, S.P., and C.O. Knowles.
1971. Unpublished results, 1971. In: C.O. Knowles, Chemistry and toxicology of quinoxaline, organotin, organofluorine, and formamidine acaricides. Environ. Hlth. Perspec., 14:93-102 (1976).

Siddaramappa, R., A.C. Tirol, J.N. Seiber, E.A. Heinrichs, and I. Watanabe.
1978. The degradation of carbofuran in paddy water and flooded soil of untreated and retreated rice fields. J. Environ. Sci. Hlth., B13(4):369-380.

Siegel, M.R.
1970. Reactions of certain trichloromethyl sulfenyl fungicides with low molecular weight thiols. In vitro studies with glutathione. J. Agric. Food Chem., 18(5):819-822.

Siegel, M.R.
1973. Distribution and metabolism of methyl 2-benzimidazolecarbamate, the fungitoxic derivative of benomyl, in strawberry plants. Phytopathology, 63:890-896.

Sijpesteijn, A.K., A. Kerkenaar, and J.C. Overeem.
1974. Observations on selectivity and mode of action of prothiocarb (SN 41 703). Meded. Fac. Landbouww. Rijksuniv. Gent, 39:1027-1034.

Sijpesteijn, A.K., and J.W. Vonk.
1974. Decomposition of bisdithiocarbamates and metabolism by plants and microorganisms. Environ. Qual. Safety, 3(Suppl.): 57-61.

Sikka, H.C., H.T. Appleton, and E.O. Gangstad.
1977. Uptake and metabolism of dimethylamine salt of 2,4-dichlorophenoxyacetic acid by fish. J. Agric. Food Chem., 25(5):1030-1033.

Sikka, H.C., G.L. Butler, and C.P. Rice.
1976a. Effects, uptake, and metabolism of methoxychlor, mirex, and 2,4-D in seaweeds. EPA-600/3-76-048, 40 pages.

Sikka, H.C., S. Miyazaki, and R.S. Lynch.
1975. Degradation of carbaryl and 1-naphthol by marine microorganisms. Bull. Environ. Contam. Toxicol., 13(6):666-672.

Sikka, H.C., L.T. Ou, and R.S. Lynch.
1976b. Degradation of 2,4,5-T by microorganisms. Abstr. Weed Sci. Soc. Amer., 71.

Silber, J., C. Previtali, and N. Silbera.
1976. Photoreactions of riboflavin in the presence of 2,4-dichlorophenoxyacetic acid (2,4-D). J. Agric. Food Chem., 24(3):679-680.

Simsiman, G.V., and G. Chesters.
1975. Persistence of endothall in the aquatic environment. Water Air Soil Pollut., 4:399-413.

Singh, B.D., and A.P. Saxena.
1976. Persistence of malathion residues on the foliage and ears of barley. Indian J. Agric. Sci., 46(3):148-151.

Singhal, J.P., and N. Singh.
1978. Adsorption and interaction of dimecron with montmorillonite. Soil Sci., 125(5):301-305.

Sinsheimer, J.E., J. Guilford, L.J. Bobrin, and D.E. Schteingart.
1972. Identification of *o,p*'-dichlorodiphenyl acetic acid as a urinary metabolite of 1-(*o*-chlorophenyl)-1-(*p*-chlorophenyl)-2,2-dichloroethane. J. Pharm. Sci., 61:314-316.

Sitkiewicz, D., I. Rakowska, M. Skonieczna, and A. Chajdak.
1977. The effect of ronnel and its oxygen analog on succinate oxidation by rat brain, liver homogenates, and mitochondria. Pestic. Biochem. Physiol., 7:501-509.

Sjoblad, R.D.
1977. Polymerization of aromatic compounds by an extracellular phenol oxidase from the fungus *Rhizoctonia praticola*. Dissert. Abstr., 37B(11):5478-5479.

Sjoblad, R.D., R.D. Minard, and J.-M. Bollag.
1976. Polymerization of 1-naphthol and related phenolic compounds by an extracellular fungal enzyme. Pestic. Biochem. Physiol., 6: 457-463.

Skalsky, H.L., and F.E. Guthrie.
1977. Affinities of parathion, DDT, dieldrin, and carbaryl for macromolecules in the blood of the rat and American cockroach and the competitive interaction of steroids. Pestic. Biochem. Physiol., 7:289-296.

Skipper, H.D., V.V. Volk, and R. Frech.
1976. Hydrolysis of a chloro-*s*-triazine herbicide. J. Agric. Food Chem., 24(1):126-129.

Skipper, H.D., V.V. Volk, M.M. Mortland, and K.V. Raman.
1978. Hydrolysis of atrazine on soil colloids. Weed Sci., 26:46-51.

Sladek, N.E.
1973. Evidence for an aldehyde possessing alkylating activity as the primary metabolite of cyclophosphamide. Cancer Res., 33:651-658.

Smelt, J.H., N.W.H. Houx, T.M. Lexmond, and H.M. Nollen.
1977a. Residues of aldicarb and its oxidation products in potato tubers after field application. Agric. Environ., 3:337-347.

Smelt, J.H., and M. Leistra.
1974. Conversion of metham-sodium to methyl isothiocyanate and basic data on the behaviour of methyl isothiocyanate in soil. Pestic. Sci., 5:401-407.

Smelt, J.H., M. Leistra, N.W.H. Houx, and A. Dekker.
1978a. Conversion rates of aldicarb and its oxidation products in soils. I. Aldicarb sulphone. Pestic. Sci., 9:279-285.

Smelt, J.H., M. Leistra, N.W.H. Houx, and A. Dekker.
1978b. Conversion rates of aldicarb and its oxidation products in soils. II. Aldicarb sulphoxide. Pestic. Sci., 9:286-292.

Smelt, J.H., M. Leistra, N.W.H. Houx, and A. Dekker.
1978c. Conversion rates of aldicarb and its oxidation products in soils. III. Aldicarb. Pestic. Sci., 9:293-300.

Smelt, J.H., M. Leistra, and S. Voerman.
1977b. Movement and rate of decomposition of ethoprophos in soil columns under field conditions. Pestic. Sci., 8:147-151.

Smelt, J.H., G.W. Wieringa, L.G.M.Th. Tuinstra, W. Luten, and C.A.A.A. Maenhout.
1975. Effects of ensilage methods and field drying on residues of DDT in grass and alfalfa. Agro-Ecosystems, 2:145-151.

Smith, A.E.
1976a. The hydrolysis of herbicidal phenoxyalkanoic esters to phenoxyalkanoic acids in Saskatchewan soils. Weed Res., 16:19-22.

Smith, A.E.
1976b. Esterification of the hydrolysis product of the herbicide dichlorfop-methyl in methanol. J. Agric. Food Chem., 24(5): 1077-1078.

Smith, A.E.
1977. Degradation of the herbicide dichlorfop-methyl in prairie soils. J. Agric. Food Chem., 25(4):893-898.

Smith, A.E.
1978. Relative persistence of di- and tri-chlorophenoxyalkanoic acid herbicides in Saskatchewan soils. Weed Res., 18:275-279.

Smith, A.E., and G.G. Briggs.
1978. The fate of the herbicide chlortoluron and its possible degradation products in soils. Weed Res., 18:1-7.

Smith, A.E., and D.R. Cullimore.
1974. The *in vitro* degradation of the herbicide bromoxynil. Can. J. Microbiol., 20:773-776.

Smith, A.E., and C.I. Mayfield.
1978. Paraquat: Determination, degradation, and mobility in soil. Water Air Soil Pollut., 9:439-452.

Smith, A.E., and T.H. Oswald.
1978. Differential detoxification of substituted phenoxyalkylcarboxylic acids by clover cell suspensions. Abstr. Weed Sci. Soc. Amer., 67-68.

Smith, A.E., and D.V. Phillips.
1976. Degradation of 4-(2,4-dichlorophenoxy)butyric acid (2,4-DB) by *Phytophthora megasperma*. J. Agric. Food Chem., 24(2):294-296.

Smith, A.E., and A. Walker.
1977. A quantitative study of asulam persistence in soil. Pestic. Sci., 8:449-456.

Smith, T.J., E.A. Crecelius, and J.C. Reading.
1977. Airborne arsenic exposure and excretion of methylated arsenic compounds. Environ. Hlth. Perspec., 19:89-93.

Soderlund, D.M.
1977. Structure-biodegradability relationships in pyrethroid insecticides. Dissert. Abstr., 37B(9):4311-4312.

Soderlund, D.M., and J.E. Casida.
1977. Effects of pyrethroid structure on rates of hydrolysis and oxidation by mouse liver microsomal enzymes. Pestic. Biochem. Physiol., 7:391-401.

Soderquist, C.J., J.B. Bowers, and D.G. Crosby.
1977. Dissipation of molinate in a rice field. J. Agric. Food Chem., 25(4):940-945.

Solomon, K.R., and R.L. Metcalf.
1974. The effect of piperonyl butoxide and triorthocresyl phosphate on the activity and metabolism of Altosid (isopropyl 11-methoxy,3,7,11-trimethyldodeca-2,4-dienoate) in *Tenebrio molitor* L. and *Oncopeltus fasciatus* (Dallas). Pestic. Biochem. Physiol., 4:127-134.

Sonawane, B.R.
1972. Metabolic studies of two carbanilate herbicides. Dissert. Abstr., 33B(1):52.

Sotiriou, N., I. Weisgerber, W. Klein, und F. Korte.
1976. Beitrage zur okologischen chemic CXVI. Verteilung und umwandlung von imugan ^{14}C in boden und hoheren pflanzen unter freilandbedingungen. Chemosphere, 5(1):53-60.

Spear, R.C., Y.-S. Lee, J.T. Leffingwell, and D. Jenkins.
1978. Conversion of parathion to paraoxon in foliar residues: Effects of dust level and ozone concentration. J. Agric. Food Chem., 26(2):434-436.

Spencer, W.F., M.M. Cliath, K.R. Davis, R.C. Spear, and W.J. Popendorf.
1975. Persistence of parathion and its oxidation to paraoxon on the soil surface as related to worker reentry into treated crops. Bull. Environ. Contam. Toxicol., 14(3):265-272.

Spencer, W.F., T.D. Shoup, and J.D. Adams.
1978. Oxidation of parathion to paraoxon in soil surface dust as affected by atmospheric conditions. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-631.

Spillner, C.J., J.R. DeBaun, and J.J. Menn.
1978. Degradation of fenitrothion in forest soil. Abstr. 175th ACS Meeting, Anaheim, CA, PEST 49.

Sprankle, P., W.F. Meggitt, and D. Penner.
1973. The role of clay, organic matter, phosphate and pH on the inactivation of glyphosate. Abstr. Weed Sci. Soc. Amer., 58.

Staiff, D.C., L.C. Butler, and J.E. Davis.
1977. Field disposal of DDT: Effectiveness of acidified powdered zinc on reduction of DDT in soil. J. Environ. Sci. Hlth., B12(1): 1-13.

Stalling, D.L., and J.N. Huckins.
1978. Metabolism of 2,4-dichlorophenoxyacetic acid (2,4-D) in bluegills and water. J. Agric. Food Chem., 26(2):447-452.

Stanley, C.W., and J.J. Murphy.
1975. Metabolism of SRA 12869 in corn plants. Abstr. 170th ACS Meeting, Chicago, IL, PEST 22.

Stanton, R.H., and M.A.Q. Khan.
1973. Hepatic mixed-function oxidase in freshwater fishes: metabolism of and interaction with cyclodiene insecticides and their photoisomers. Amer. Zool., 13(4):1306-1307.

Statham, C.N., and J.J. Lech.
1975. Metabolism of 2',5-dichloro-4'-nitro-salicylanilide (Bayer 73) in rainbow trout (*Salmo gairdneri*). J. Fish. Res. Bd. Canada, 32(4):515-522.

Statham, C.N., S.K. Pepple, and J.J. Lech.
1975. Biliary excretion products of 1-[1-^{14}C]naphthyl-*N*-methylcarbamate (carbaryl) in rainbow trout (*Salmo gairdneri*). Drug Metab. Dispos., 3(5):400-406.

Steen, R.C.
1973. A study of 2,4-D side-chain degradation in plants. Dissert. Abstr. 33B(9):4122.

Steen, R.C., I.R. Schultz, D.C. Zimmerman, and J.R. Fleeker.
1974. Absence of 3-(2,4-dichlorophenoxy)propionic acid in plants treated with 2,4-dichlorophenoxyacetic acid. Weed Res., 14:23-28.

Stein, K., and J. Portig.
1976. Oxidative transformation of hexachlorocyclohexane in the rat. Naunyn Schmied. Arch. Pharmacol., 293:R51.

Stein, K., J. Portig, and W. Koransky.
1977. Oxidative transformation of hexachlorocyclohexane in rats and with rat liver microsomes. Naunyn-Schmied.'s Arch. Pharmacol., 298:115-128.

Stein, V.B., and K.A. Pittman.
1977. Identification of a mirex metabolite from monkeys. Bull. Environ. Contam. Toxicol., 18(4):425-427.

Stein, V.B., K.A. Pittman, and M.W. Kennedy.
1976. Characterization of a mirex metabolite from monkeys. Bull. Environ. Contam. Toxicol., 15(2):140-146.

Steinwandter, H.
1976a. Zum lindanmetabolismus an pflanzen. I. Bildung von hexachlorbenzol. Chemosphere, 5(2):119-125.

Steinwandter, H.
1976b. Zum lindanmetabolismus an pflanzen. II. Bildung von α-HCH. Chemosphere, 5(4):221-225.

Steinwandter, H.
1976c. Beitrage zur umwandlung der HCH-isomere durch einwirkung von UV-strahlen. I. Isomerisierung des lindans in α-HCH. Chemosphere, 5(4):245-248.

Steinwandter, H.,
1978. Experiments on lindane metabolism in plants. II. Formation of β-HCH. Bull. Environ. Contam. Toxicol., 20: 535-536.

Steinwandter, H., and H. Schluter.
1978. Experiments on lindane metabolism in plants. IV. A kinetic investigation. Bull. Environ. Contam. Toxicol., 20:174-179.

Stenersen, J.
1969. Demethylation of the insecticide bromophos by a glutathion-dependent liver enzyme and by alkaline buffers. J. Econ. Entomol., 62(5):1043-1045.

Stephenson, G.R., D.R. Dilley, and S.K. Ries.
1971. Influence of light and sucrose on N-glucosyl pyrazon formation in red beet. Weed Sci., 19(4):406-409.

Stephenson, G.R., J.E. McLeod, and S.C. Phatak.
1974. Varietal differences in the tolerance of tomatoes to metribuzin. Abstr. Weed Sci. Soc. Amer., 122-123.

Stephenson, G.R., J.E. McLeod, and S.C. Phatak.
1976. Differential tolerance of tomato cultivars to metribuzin. Weed Sci., 24(2):161-165.

Stevens, J.T., L.L. Hall, J.D. Farmer, L.C. DiPasquale, N. Chernoff, and W.F. Durham.
1977. Disposition of ^{14}C and/or ^{74}As-cacodylic acid in rats after intravenous, intratracheal, or peroral administration. Environ. Hlth. Perspec., 19:151-157.

Stewart, D.K.R., and S.O. Gaul.
1977a. Dihydrochlordene dicarboxylic acid residues in soil treated with high rates of aldrin. Bull. Environ. Contam. Toxicol., 17(6):712-713.

Stewart, D.K.R., and S.O. Gaul.
1977b. Persistence of 2,4-D, 2,4,5-T and dicamba in a dykeland soil. Bull. Environ. Contam. Toxicol., 18(2):210-218.

Stijve, T., and E. Cardinale.
1972. On the residues associated with the use of technical grade BHC with special reference to the occurrence and determination of three pentachlorocyclohex-1-ene isomers. Mitt. Lebensmittuntersuch, u hyg., 63:142-153.

Still, G.G., H.M. Balba, and E.R. Mansager.
1978. Characteristics and analysis of bound pesticide residues in plants. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-26.

Still, G.G., and E.R. Mansager.
1975. Alfalfa metabolism of propham. Pestic. Biochem. Physiol., 5:515-522.

Still, G.G., and D.G. Rusness.
1977. *S*-Cysteinyl-hydroxychlorpropham: Formation of the *S*-cysteinyl conjugate of isopropyl-3'-chloro-4'-hydroxycarbanilate in oat (*Avena sativa* L.). Pestic. Biochem. Physiol., 7:210-219.

Stotter, D.A., R.D. Thomas, and M.T. Wilson.
1977. Reductive dechlorination of DDT by haem proteins. Bioinorg. Chem., 7:87-93.

Strang, R.H.
1973. A study of the absorption, translocation and metabolism of two pyridazinone herbicides (San 6706, San 9789) by cotton, corn and soybean. Dissert. Abstr., 33B(12):5606.

Struck, R.F.
1971. Isolation and identification of a major anionic urinary metabolite of cyclophosphamide. Amer. Assoc. Cancer Res. Proc. 12:Abstr. 269.

Struck, R.F., M.C. Kirk, L.B. Mellett, S. El Dareer, and D.L. Hill.
1971. Urinary metabolites of the antitumor agent cyclophosphamide. Mol. Pharmacol., 7:519-529.

Struif, B., L. Weil, und K.E. Quentin.
1978. Verhalten herbizider phenoxy-alkan-carbonsauren bei der wasseraufbereitung mit ozon. Z.f. Wasser- und Abwasser-Forsch., 11:118-127.

Subba-Rao, R.V., and M. Alexander.
1977a. Products formed from analogues of 1,1,1-trichloro-2,2-bis (*p*-chlorophenyl)ethane (DDT) metabolites by *Pseudomonas putida*. Appl. Environ. Microbiol., 33(1):101-108.

Subba-Rao, R.V., and M. Alexander.
1977b. Cometabolism of products of 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane (DDT) by *Pseudomonas putida*. J. Agric. Food Chem., 25(4):855-858.

Sudhakar-Barik, R.S., and N. Sethunathan.
1978a. Biological hydrolysis of parathion in natural ecosystems. J. Environ. Qual., 7(3):346-348.

Sudhakar-Barik, R.S., and N. Sethunathan.
1978b. Metabolism of nitrophenols in flooded soils. J. Environ. Qual., 7(3):349-352.

Sudhakar-Barik, R.S., R. Siddaramappa, and N. Sethunathan.
1976. Metabolism of nitrophenols by bacteria isolated from parathion-amended flooded soil. Antonie van Leeuwenhoek J. Microbiol. Serol., 42(4):461-470.

Suett, D.L.
1975. Persistence and degradation of chlorfenvinphos, chlormephos, disulfoton, phorate and pirimiphos-ethyl following spring and late-summer soil application. Pestic. Sci., 6:385-393.

Sugiura, K., N. Tanaka, N. Takeuchi, M. Toyoda, and M. Goto.
1976. Accumulation and elimination of PCBs in the mouse. Chemosphere, 5(1):31-37.

Sullivan, L.J., B.H. Chin, and C.P. Carpenter.
1972. *In vitro* vs. *in vivo* chromatographic profiles of carbaryl anionic metabolites in man and lower animals. Toxicol. Appl. Pharmacol., 22:161-174.

Sundstrom, G.
1977. Metabolic hydroxylation of the aromatic rings of 1,1-dichloro-2,2-bis(4-chlorophenyl)ethylene (*p,p*'-DDE) by the rat. J. Agric. Food Chem., 25(1):18-21.

Sundstrom, G., O. Hutzinger, and S. Safe.
1976. The metabolism of 2,2',4,4',5,5'-hexachlorobiphenyl by rabbits and mice. Chemosphere, 5(4):249-253.

Supak, J.R.
1972. The volatilization, degradation, adsorption, and desorption characteristics of aldicarb [2-methyl-2-(methylthio)propionaldehyde *O*-(methylcarbamoyl)oxime] in soils and clays. Dissert. Abstr., 33B(3):981-982.

Supak, J.R., A.R. Swoboda, and J.B. Dixon.
1977. Volatilization and degradation losses of aldicarb from soils. J. Environ. Qual., 6(4):413-417.

Surovtzeva, E.G., and N.S. Funtikova.
1978. Metabolism of 3,4-dichloroaniline by *Pseudomonas* strains. Mikrobiolog., 47(1):21-25.

Suss, A., G. Fuchsbichler, and Ch. Eben.
1978. Abbau von anilin, 4-chloranilin und 3,4-dichloranilin in verschiedenen boden. Z. Pflanz. Bodenkd., 141:57-66.

Suss, V.A., and Ch. Eben.
1978. Abbau von monolinuron in verschiedenen boden. Z. Pflanzenernaehr. Bodenkd., 141:217-229.

Suzuki, A., M. Shimura, T. Kikuchi, and Y. Sekizawa.
1977. Residue analyses on 2-amino-4-phenylthiazole, a piscine anesthetic, in fishes - III. Metabolism in rainbow trout and carp. Bull. Japan Soc. Sci. Fish., 43(7):837-847.

Suzuki, T.
1977. Metabolism of pentachlorophenol by a soil microbe. J. Environ. Sci. Hlth., B12(2):113-127.

Suzuki, T.
1978. Enzymatic methylation of pentachlorophenol and its related compounds by cell-free extracts of *Mycobacterium* sp. isolated from soil. J. Pestic. Sci., 3:441-443.

Suzuki, T., N. Ohno, and J. Miyamoto.
1976. New metabolites of (+)-*cis* fenothrin, 3-phenoxybenzyl (+)-*cis* chrysanthemumate, in rats. J. Pestic. Sci., 1:151-152.

Suzuki, T., and M. Takeda.
1976a. Microbial metabolism of *N*-methylcarbamate insecticide. I. Metabolism of *o*-*sec*-butylphenyl *N*-methylcarbamate by *Aspergillus niger* van Tieghem. Chem. Pharm. Bull., 24(9):1967-1975.

Suzuki, T., and M. Takeda.
1976b. Microbial metabolism of *N*-methylcarbamate insecticide. II. Synthesis of metabolites of *o*-*sec*-butylphenyl *N*-methylcarbamate. Chem. Pharm. Bull., 24(9):1976-1982.

Suzuki, T., and M. Takeda.
1976c. Microbial metabolism of *N*-methylcarbamate insecticide. III. Time course in metabolism of *o*-*sec*-butylphenyl *N*-methylcarbamate by *Aspergillus niger* and species differences among soil fungi. Chem. Pharm. Bull., 24(9):1983-1987.

Suzuki, T., and M. Takeda.
1976d. Microbial metabolism of *N*-methylcarbamate insecticide. IV. New metabolites of *o*-*sec*-butylphenyl *N*-methylcarbamate by *Cladosporium cladosporioides*. Chem. Pharm. Bull., 24(9):1988-1991.

Swann, R.L., M. Sauderhoff, W. Braun, and H.O. Senkbeil.
1976. Identification and confirmation of metabolites of phenyl *N*,*N*'-dimethylphosphorodiamidate in rat urine and cows milk by TLC, GC/MS, NMR and IR. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 90.

Sweeney, R.A.
1969. Metabolism of lindane by unicellular algae. Proc. 12th Conf. Great Lakes Res., 98-102.

Swoboda, A.R., and M.G. Merkle.
1977. Movement of methazole and its degradation products in soils. J. Environ. Qual., 6(4):385-388.

Szalkowski, M.B., and D.E. Stallard.
1977. Effect of pH on the hydrolysis of chlorothalonil. J. Agric. Food Chem., 25(1):208-210.

Szuts, T., S. Olsson, N.G. Lindquist, and S. Ullberg.
1978. Long-term fate of [^{14}C]nicotine in the mouse: Retention in the bronchi, melanin-containing tissues and urinary bladder wall. Toxicol., 10:207-220.

Tabet, J.C.K., and E.P. Lichtenstein.
1976. Degradation of [^{14}C]photodieldrin by *Trichoderma viride* as affected by other insecticides. Can. J. Microbiol., 22(9):1345-1356.

Tadros, W., V.B. Baghos, H. Wissa, and N.Z. Soliman.
1976. Reactions of halogenated insecticides with aromatic amines: Part I - Reactions of asymmetric 1,1-bis(*p*-substituted-phenyl)-2,2,2-trichloroethanes with dimethylaniline. Indian J. Chem., 14B:510-512.

Tafuri, F., M. Businelli, L. Scarponi, and C. Marucchini.
1977. Decline and movement of AG chlordane in soil and its residues in alfalfa. J. Agric. Food Chem., 25(2):353-356.

Takade, D.Y., T. Allsup, A. Khasawinah, T.S. Kao, and T. Fukuto.
1976a. Metabolism of *O*,*O*-dimethyl *S*-[α-(carboethoxy)benzyl] phosphorodithioate (phenthoate) in the white mouse and house flies. Pestic. Biochem. Physiol., 6:367-376.

Takade, D.Y., M.-S. Seo, T.S. Kao, and T.R. Fukuto.
1976b. Alteration of O,O-dimethyl S-[α-(carboethoxy)benzyl]phosphorodithioate (phenthoate) in citrus, water, and upon exposure to air and sunlight. Arch. Environ. Contam. Toxicol., 5:63-86.

Takamizawa, A., S. Matsumoto, and T. Iwata.
1974. 4-Hydroxycyclophosphamide anhydro-dimer: Revised structure of the fenton oxidation product of cyclophosphamide. Tetrahedron Lett., 6:517-520.

Takamizawa, A., Y. Tochino, Y. Hamashima, and T. Iwata.
1972. Studies on cyclophosphamide metabolites and their related compounds. I. Chem. Pharm. Bull., 20(8):1612-1616.

Takase, I., and H. Nakamura.
1974. The fate of ethylthiometon (O,O-diethyl S-[2-(ethylthio) ethyl]phosphorodithioate) in paddy soil. J. Agric. Chem. Soc. Japan, 48(1):29-34.

Takase, I., T. Nakahara, and K. Ishizuka.
1978. Degradation of 3-(3-chloro-4-chlorodifluoromethylthiophenyl)-1,1-dimethylurea (Clearcide) in paddy soils. J. Pestic. Sci., 3:9-19.

Takimoto, Y., M. Hirota, H. Inui, and J. Miyamoto.
1976. Decomposition and leaching of radioactive sumithion in 4 different soils under laboratory conditions. J. Pestic. Sci., 1:131-143.

Takimoto, Y., and J. Miyamoto.
1976. Studies on accumulation and metabolism of sumithion in fish. J. Pestic. Sci., 1:261-271.

Takimoto, Y., M. Ohshima, and J. Miyamoto.
1978. Degradation and fate of fenitrothion applied to harvested rice grains. J. Pestic. Sci., 3:277-290.

Talekar, N.S.
1974. Environmental factors affecting the penetration, translocation, and metabolism of some insecticides in pea plants. Dissert. Abstr., 34B(9):4427-4428.

Talekar, N.S., E.M. Lee, and L.T. Sun.
1977a. Absorption and translocation of soil and foliar applied ^{14}C-carbofuran and ^{14}C-phorate in soybean and mungbean seeds. J. Econ. Entomol., 70(6):685-688.

Talekar, N.S., L.-T. Sun, E.-M. Lee, and J.-S. Chen.
1977b. Persistence of some insecticides in subtropical soil. J. Agric. Food Chem., 25(2):348-352.

Tallant, M.J., B.H. Chin, and L.J. Sullivan.
1974. The excretion and distribution of DS-15647 and its sulfone derivative in the rat with urinary excretion of DS-15647 in the dog. Abstr. 168th ACS Meeting, Atlantic City, NJ, PEST 57.

Tallant, M.J., and L.J. Sullivan.
1974. Metabolism of DS-15647 and its sulfone derivative in the rat and DS-15647 in the dog. Abstr. 168th ACS Meeting, Atlantic City, NJ, PEST 56.

Tamari, M.

1977. Studies on the metabolic pathway of ciliatine (2-aminoethylphosphonic acid) in mammal. J. Agric. Chem. Soc. Japan, 51(11): R131-R139.

Tamari, M., S. Hasegawa, and M. Kametaka.

1976a. Metabolisme de l'acide 2-aminoethylphosphonique (Ciliatine) chez le poulet. Agric. Biol. Chem., 40(10):2117-2118.

Tamari, M., M. Horiguchi, and M. Kandatsu.

1975. Digestion, absorption, and excretion of bound-form ciliatine in rats (studies on metabolism of ciliatine (2-aminoethylphosphonic acid) Part II. J. Agric. Chem. Soc. Japan, 49(10):533-538.

Tamari, M., M. Horiguchi, and M. Kandatsu.

1976b. Degradation of ciliatine (2-aminoethylphosphonic acid) by the mutant strain Tm-1 of *Escherichia coli*. J. Japan Biochem. Soc., 48(8):810-813.

Tanaka, F.S., and R.G. Wien.

1977. Free radical oxidation of 3-(4-chlorophenyl)-1,1-dimethylurea in aqueous media. Abstr. 173rd ACS Meeting, New Orleans, LA, PEST 5.

Tanaka, F.S., R.G. Wien, and R.G. Zaylskie.

1976a. Photolysis of 3-(4-chlorophenyl)-1,1-dimethylurea in dilute aqueous solution. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 97.

Tanaka, F.S., R.G. Wien, and R.G. Zaylskie.

1977a. Photolysis of 3-(4-chlorophenyl)-1,1-dimethylurea in dilute aqueous solution. J. Agric. Food Chem., 25(5):1068-1072.

Tanaka, K., N. Kurihara, and M. Nakajima.

1976b. Comparative insecticidal activities and metabolic rates of lindane and its hexadeuterio-analog. Pestic. Biochem. Physiol., 6:386-391.

Tanaka, K., N. Kurihara, and M. Nakajima.

1976c. Metabolism of lindane in house flies: Metabolic desaturation, dehydrogenation, and dehydrochlorination, and conjugation with glutathione. Pestic. Biochem. Physiol., 6:392-399.

Tanaka, K., N. Kurihara, and M. Nakajima.

1977b. Pathways of chlorophenol formation in oxidative biodegradation of BHC. Agric. Biol. Chem., 41(4):723-725.

Tashiro, S., and F. Matsumura.

1977. Metabolic routes of *cis*- and *trans*-chlordane in rats. J. Agric. Food Chem., 25(4):872-880.

Tashiro, S., and F. Matsumura.

1978. Metabolism of *trans*-nonachlor and related chlordane components in rat and man. Arch. Environ. Contam. Toxicol., 7:113-127.

Taylor, A.W., D.E. Glotfelty, B.C. Turner, R.E. Silver, H.P. Freeman, and A. Weiss.
1977. Volatilization of dieldrin and heptachlor residues from field vegetation. J. Agric. Food Chem., 25(3):542-548.

Taylor, D.G., and P.W. Trudgill.
1978. Metabolism of cyclohexane carboxylic acid by *Alcaligenes* strain W1. J. Bacteriol., 134(2):401-411.

Taylor, H.F., and R.L. Wain.
1978. Studies on plant growth-regulating substances. LII. Growth retardation by 3,5-dichlorophenoxyethylamine and 3,5-dichlorophenoxybutyric acid arising from their conversion to 3,5-dichlorophenoxyacetic acid in tomato plants. Ann. Appl. Biol., 89:271-275.

Tekitek, A., M. Rojas, J. BerreurOBonnenfant, G. Pham, F. Nau, J.-P. Ferezou, M. Barbier, and E. Lederer.
1977. Inhibition de methylations biologiques par la t,t-farnesylacetone, constituant de la glande androgene du crabe male *Carcinus maenas*. C.R. Acad. Sci. Ser. D, 285:825-828.

Terce, M., E. Lefebvre-Drouet, and R. Calvet.
1977. Degradation of adsorbed atrazine on an aluminum montmorillonite. Chemosphere, 6(11):753-758.

Terranova, A.C.
1969. The residual fate of *N*,*N*,*N'*,*N'*-tetramethyl-*p*-piperidinophosphonic diamide after injection, tarsal contact, and topical application to the boll weevil. J. Econ. Entomol., 62(4):821-823.

Terranova, A.C., and M.M. Crystal.
1970. The fate of *N*,*N'*-tetramethylenebis(1-aziridinecarboxamide) in the black blow fly and the screw-worm fly. J. Econ. Entomol., 63(2):455-458.

Terriere, L.C., and S.J. Yu.
1977. Juvenile hormone analogs: *In vitro* metabolism in relation to biological acitivity in blow flies and flesh flies. Pestic. Biochem. Physiol., 7:161-168.

Testa, B., P. Jenner, A.H. Beckett, and J.W. Gorrod.
1976. A reappraisal of the steroselective metabolism of nicotine to nicotine-1'-*N*-oxide. Xenobiotica, 6(9):553-556.

Tewfik, M.S., and Y.A. Hamdi.
1975. Metabolism of fluorodifen by soil microorganisms. Soil Biol. Biochem., 7:79-82.

Thompson, R.P.
1975. A comparative study on the fate of cyanazine and atrazine in plants. Dissert. Abstr., 35B(11):5225.

Thongsinthusak, T.
1975. Hydroxylation of dihydroisodrin as an indicator of mixed-function oxidase metabolic capability of black cutworm *Agrotis ypsilon* and cabbage looper *Trichoplusia ni* larvae (Lepidoptera: Noctuidae). Dissert. Abstr., 36(2):567.

Thongsinthusak, T., and R.I. Krieger.
1976. Dihydroisodrin hydroxylation as an indicator of monooxygenase capability of black cutworm *Agrotis ypsilon* and cabbage looper *Trichoplusia ni* larvae. Comp. Biochem. Physiol., 54C:7-12.

Thonnart, N., M. Vanhaelen, and R. Vanhaelen-Fastre.
1977. *In vitro* metabolism of a new 4-hydroxycoumarin anticoagulant. Structure of an unusual metabolite. J. Med. Chem., 20:604-606.

Tichy, M., J. Havrdova, and M. Cikrt.
1975. Comments on the mechanism of excretion of mercury compounds via bile in rats. Arch. Toxicol., 33:267-271.

Tiedje, J.M.
1969. Metabolism of 2,4-dichlorophenoxyacetic acid by enzymes of an *Arthrobacter* sp. Dissert. Abstr., 29B(11):4298.

Tiedje, J.M., G.G. Briggs, and M. Alexander.
1968. Phenoxyacetate detoxication by *Arthrobacter* sp. Amer. Soc. Microbiol. Bacteriol. Proc., A32:6.

Tiedje, J.M., and M.L. Hagedorn.
1975. Degradation of alachlor by a soil fungus, *Chaetomium globosum*. J. Agric. Food Chem., 23(1):77-81.

Tietz, H.
1960. Metabolisme des insecticides et acaricides du groupe du demeton-methyl. Phytiatrie-Phytopharmacie, 9:167-180.

Tillmanns, G.M., P.R. Wallnofer, G. Engelhardt, K. Olie, and O. Hutzinger.
1978. Oxidative dealkylation of five phenylurea herbicides by the fungus *Cunninghamella echinulata* Thaxter. Chemosphere, 7(1):59-64.

Tocco, D.J., C. Rosenblum, C.M. Martin, and H.J. Robinson.
1966. Absorption, metabolism, and excretion of thiabendazole in man and laboratory animals. Toxicol. Appl. Pharmacol., 9:31-39.

Tokuda, T., M. Nishiki, H. Hoshi, K. Shinoda, M. Ishida, and T. Misato.
1976. Metabolic fate of fthalide (4,5,6,7-tetrachlorophthalide) in compost. J. Pestic. Sci., 1(4):283-294.

Tomizawa, C., T. Endo, and H. Naka.
1974. Fate and significance of labelled insecticide residues in rice. In: Isotope tracer studies of chemical residues in food and the agricultural environment. Internat. Atomic Energy Agency, Vienna, Austria.

Tomizawa, C., Y. Uesugi, I. Ueyama, and H. Yamamoto.
1976. Movement and metabolism of *S*-benzyl *O,O*-diisopropyl phosphorothiolate (Kitzazin P) and *O*-ethyl *S,S*-diphenyl phosphorothiolate (Edifenphos) in various types of soils. J. Environ. Sci. Hlth., B11(3):231-251.

Torkelson, A.R., J.A. LaBudde, and J.H. Weikel, Jr.
1974. The metabolic fate of cyclophosphamide. Drug Metab. Rev., 3(1):131-165.

Torstensson, N.T.L.
1974. Degradation of 2,4-D and MCPA in soils of low pH. Environ. Qual. Safety, 3(Suppl.):262-265.

Torstensson, N.T.L., and A. Aamisepp.
1977. Detoxification of glyphosate in soil. Weed Res., 17: 209-212.

Townsend, M.G., and K.A. Tarrant.
1977. *In vitro* studies of warfarin metabolism by birds and mammals. Xenobiotica, 7(1-2):114-115.

Trela, J.M., W.J. Ralston, and H.B. Gunner.
1968. Metabolism of diazinon by soil microflora. Amer. Soc. Microbiol. Bacteriol. Proc., A30:6.

Tsai, W.-f.
1974. Metabolism of propanil: Solubilization and purification of a propanil hydrolyzing aryl acylamidase from rice leaves. Dissert. Abstr., 35B(4):1478.

Tseng, Y.-C.L.
1973. Effects of phenobarbital and dieldrin treatment on biochemical changes in liver and metabolism of dicrotophos, dimethoate, and phosphamidon insecticides in mice. Dissert. Abstr., 34B(2):706.

Tsorbatzoudi, E., D. Vockel, und F. Korte.
1976. Beitrage zur okologischen chemie CXI. Metabolismus von buturon-^{14}C in algen. Chemosphere, 5(1):49-52.

Tu, C.M.
1976. Utilization and degradation of lindane by soil microorganisms. Arch. Microbiol., 108:259-263.

Tucker, E.S., V.W. Saeger, and O. Hicks.
1976. Activated sludge primary biodegradation of polychlorinated biphenyls. Bull. Environ. Contam. Toxicol., 14(6):705-713.

Tuey, D.B., and H.B. Matthews.
1977. Pharmacokinetics of 3,3',5,5'-tetrachlorobiphenyl in the male rat. Drug Metab. Dispos., 5(5):444-450.

Tulp, M.Th.M., and O. Hutzinger.
1978. Rat metabolism of polychlorinated dibenzo-*p*-dioxins. Chemosphere, 7(9):761-768.

Tulp, M.Th.M., R. Schmitz, and O. Hutzinger.
1978. The bacterial metabolism of 4,4'-dichlorobiphenyl, and its suppression by alternative carbon sources. Chemosphere, 7(1):103-108.

Tulp, M.Th.M., G. Sundstrom, and O. Hutzinger.
1976. The metabolism of 4,4'-dichlorobiphenyl in rats and frogs. Chemosphere, 5(6):425-432.

Turner, B.C., and J.H. Caro.
1973. Uptake and distribution of carbofuran and its metabolites in field-grown corn plants. J. Environ. Qual., 2(2):245-247.

Turner, B.C., D.E. Glotfelty, and A.W. Taylor.
1977. Photodieldrin formation and volatilization from grass. J. Agric. Food Chem., 25(3):548-550.

Turner, D.M.
1975. Influence of route of administration on metabolism of $[^{14}C]$nicotine in four species. Xenobiotica, 5(9):553-561.

Turner, D.M., A.K. Armitage, R.H. Briant, and C.T. Dollery.
1975. Metabolism of nicotine by the isolated perfused dog lung. Xenobiotica, 5(9):539-551.

Udagawa, T., T. Miyata, and T. Saito.
1974. Metabolism of continuous three weeks administered ^{14}C-pyridafenthion, *O*,*O*-diethyl-*O*-(3-oxo-2-phenyl-2H-pyridazine-6-yl) phosphorothioate, in mouse. Botyu-Kagaku, 39(1):15-18.

Ueji, M., J. Kanazawa, and S. Iwanade.
1978. Uptake and translocation of 2-*sec*-butylphenyl *N*-methylcarbamate (BPMC) in cucumber and komatsuna plants. J. Pestic. Sci., 3:371-377.

Uesugi, Y., and H.D. Sisler.
1978. Metabolism of a phosphoramidate by *Pyricularia oryzae* in relation to tolerance and synergism by a phosphorothiolate and isoprothiolane. Pestic. Biochem. Physiol., 9:247-254.

Ueyama, I., I. Takase, and C. Tomizawa.
1978. Metabolism of edifenphos (*O*-ethyl diphenyl phosphorodithiolate) in mouse and rat. Agric. Biol. Chem., 42(4): 885-887.

Usui, K., T. Shishido, and J. Fukami.
1977. Glutathione S-transferases of rat liver active on organophosphorus triesters. Agric. Biol. Chem., 41(12):2491-2493.

Valange, B.
1975. Degradation du malathion formule sur attapulgite: 1. Cinetique chimique. Parasitica, 31(3):69-83.

Van Alfen, N.K.
1973. Microbial metabolism of the fungicide, 2,6-dichloro-4-nitroaniline. Dissert. Abstr. 34B(2):487.

Van Alfen, N.K., and T. Kosuge.
1976. Metabolism of the fungicide 2,6-dichloro-4-nitroaniline in soil. J. Agric. Food Chem., 24(3):584-588.

Van Auken, O.W., and M. Hulse.
1978. Translocation and metabolism of leaf applied hexachlorophene in peanuts. Physiol. Plant., 44:205-214.

VandenHeuvel, W.J.A., D.E. Wolf, B.H. Arison, R.P. Buhs, J.R. Carlin, R.L. Ellsworth, T.A. Jacob, F.R. Koniuszy, J.L. Smith, N.R. Trenner, R.W. Walker, and F.J. Wolf.
1978. Urinary metabolites of cambendazole. J. Agric. Food Chem., 26(6):1357-1364.

van der Steen, J., E.C. Timmer, J.G. Westra, and C. Benckhuysen.
1973. 4-Hydroperoxidation in the fenton oxidation of the antitumor agent cyclophosphamide. J. Amer. Chem. Soc., 95:7535-7536.

Van Dyk, L.P., and A. Van Der Linde.
1976. Persistence of endosulfan in soils of the Loskop Dam irrigation area. Agrochemophysica, 8:31-34.

Van Peteghem, C.H., and A.M. Heyndrickx.
1975. Beta oxidation of chlorophenoxybutyric acid herbicides in guinea pigs. Bull. Environ. Contam. Toxicol., 14(5):632-640.

Vanstone, D.E., and E.H. Stobbe.
1978. Root uptake, translocation, and metabolism of nitrofluorfen and oxyfluorfen by fababeans (*Vicia faba*) and green foxtail (*Setaria viridis*). Weed Sci., 26(4):389-392.

Vasavada, P.C., and F.W. Forney.
1975. Microbial degradation of piperonylic acid. Antonie van Leeuwenhoek J. Microbiol. Serol., 41(4):479-491.

Veerasekaran, P., R.C. Kirkwood, and W.W. Fletcher.
1976. The mode of action of asulam [methyl(4-aminobenzenesulphonyl)carbamate] in bracken. Bot. J. Linn. Soc., 73:247-268.

Vendrig, J., and P. Dierickx.
1976. Some aspects of the mode of action and metabolism of orthonil in plants. Arch. Environ. Contam. Toxicol., 4(4):395-403.

Venkateswarlu, K., T.K.S. Gowda, and N. Sethunathan.
1977. Persistence and biodegradation of carbofuran in flooded soils. J. Agric. Food Chem., 25(3):533-536.

Venkateswarlu, K., and N. Sethunathan.
1978. Degradation of carbofuran in rice soils as influenced by repeated applications and exposure to aerobic conditions following anaerobiosis. J. Agric. Food Chem., 26(5):1148-1151.

Verweij, A., and H.L. Boter.
1976. Degradation of *S*-2-di-isopropylaminoethyl *O*-ethyl methylphosphonothioate in soil: Phosphorus-containing products. Pestic. Sci., 7:355-362.

Viswanathan, R., W. Klein, and F. Korte.
1976. Contributions to ecological chemistry CXXX. Balance of the fate of imugan-C-14 in rats upon long term feeding. Chemosphere, 5:357-362.

Viswanathan, R., W. Klein, and F. Korte.
1978a. Contributions to ecological chemistry CXLII. Separation and identification of metabolites excreted by rats after long term oral administration of imugan-^{14}C. Chemosphere, 7(1):71-78.

Viswanathan, R., I. Scheunert, J. Kohli, W. Klein, and F. Korte.
1978b. Long-term studies on the fate of 3,4-dichloroaniline-C in a plant-soil-system under outdoor conditions. J. Environ. Sci. Hlth., B13(3):243-259.

Vogeler, K., Ph. Dreze, A. Rapp, H. Steffan, and H. Ullemeyer.
1977. Distribution and metabolism of propineb in apples and grapes, and of its degradation products propylene thiourea and ethylene thiourea in apples. Pflanz.-Nachrichten, 30(1):72-97.

Von Endt, D.W., P.C. Kearney, and D.D. Kaufman.
1968. Degradation of monosodium methanearsonic acid by soil microorganisms. J. Agric. Food Chem., 16(1):17-20.

Vonk, J.W.
1978. New aspects of the metabolism of [^{14}C]zineb on lettuce. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-515.

Vonk, J.W., B. Mihanovic, and A.K. Sijpesteijn.
1977. A biological mechanism for the conversion of thiophanate-methyl into benzimidazol-2-yl carbamate (MBC) in plant tissue. Neth. J. Pl. Path., 83(Suppl. 1):269-276.

Vonk, J.W., and A.K. Sijpesteijn
1976. Formation of ethylenethiourea from 5,6-dihydro-3H-imidazo [2,1-C]-1,2,4-dithiazole-3-thione by microorganisms and reducing agents. J. Environ. Sci. Hlth., B11(1):33-47.

Waggoner, T.B., C.A. Anderson, J.A. Ciarletta, and T.J. Olsen.
1974. Degradation of metribuzin in soil and effects on rotational crops. Abstr. Weed Sci. Soc. Amer., 121.

Wahid, P.A., and N. Sethunathan.
1978. Sorption-desorption of parathion in soils. J. Agric. Food Chem., 26(1):101-105.

Walker, A.
1976a. Simulation of herbicide persistence in soil. I. Simazine and prometryne. Pestic. Sci., 7:41-49.

Walker, A.
1976b. Simulation of herbicide persistence in soil. III. Propyzamide in different soil types. Pestic. Sci., 7:59-64.

Walker, A.
1978a. Simulation of the persistence of eight soil-applied herbicides. Weed Res., 18:305-313.

Walker, A.
1978b. The degradation of methazole in soil. I. Effects of soil type, soil temperature and soil moisture content. Pestic. Sci., 9:326-332.

Walker, A., and W. Bond.
1977. Persistence of the herbicide AC 92,553, N-(1-ethylpropyl)-2,6-dinitro-3,4-xylidine, in soils. Pestic. Sci., 8:359-365.

Walker, A., W. Bond, and H.A. Roberts.
1975a. Soil temperature and persistence of methazole. Proc. 9th Int. Velsicol Symp., 1-4.

Walker, A., and M.G. Roberts.
1978. The degradation of methazole in soil. II. Studies with methazole, methazole degradation products and diuron. Pestic. Sci., 9:333-341.

Walker, A., and J.A. Thompson.
1977. The degradation of simazine, linuron and propyzamide in different soils. Weed Res., 17:399-405.

Walker, C.H., and D.J. Jefferies.
1978. The postmortem reductive dechlorination of p,p'-DDT in avian tissues. Pestic. Biochem. Physiol., 9:203-210.

Walker, N., N.F. Janes, J.R. Spokes, and P. Van Berkum.
1975b. Degradation of 1-naphthol by a soil pseudomonad. J. Appl. Bact., 39:281-286.

Walker, W.W.
1976c. Chemical and microbiological degradation of malathion and parathion in an estuarine environment. J. Environ. Qual., 5(2): 210-216.

Walker, W.W., and B.J. Stojanovic.
1973. Microbial versus chemical degradation of malathion in soil. J. Environ. Qual., 2(2):229-232.

Walker, W.W., and B.J. Stojanovic.
1974. Malathion degradation by an Arthrobacter species. J. Environ. Qual., 3(1):4-10.

Wallnofer, P.
1968. Abbau von 1,4-oxathiin-derivaten durch den schimmelpilz Rhizopus japonicus. Naturwissen., 55(7):351.

Wallnofer, P., und G. Engelhardt.
1971. Der abbau von phenylamiden durch Bacillus sphaericus. Arch. Mikrobiol., 80:315-323.

Wallnofer, P.R., G. Tillmanns, and G. Engelhardt.
1977. Degradation of acylanilide pesticides by Aspergillus niger. Pestic. Biochem. Physiol., 7:481-485.

Wallnofer, P., G. Tillmanns, R. Thomas, C. Wunsche, J. Kurz, and H.J. Jarczyk.
1976. Mikrobieller abbau des herbizids methabenzthiazuron und identifizierung der metaboliten. Chemosphere, 5:377-382.

Wallnofer, P.R., W. Ziegler, G. Engelhardt, and H. Rothmeier.
1978. Transformation of dinitrophenol-herbicides by Azotobacter sp. Chemosphere, 7(12):967-972.

Walsh, L.M., and D.R. Keeney.
1974. Behavior of inorganic arsenicals in soil. Abstr. 168th ACS Meeting, Atlantic City, NJ, PEST 11.

Walter, J.P., E.F. Eastin, and M.G. Merkle.
1970. The persistence and movement of fluorodifen in soils and plants. Weed Res., 10:165-171.

Walter-Echols, G., and E.P. Lichtenstein.
1977. Microbial reduction of phorate sulfoxide to phorate in a soil-lake mud-water microcosm. J. Econ. Entomol., 70(4):505-509.

Walter-Echols, G., and E.P. Lichtenstein.
1978a. Movement and metabolism of [^{14}C]phorate in a flooded soil system. J. Agric. Food Chem., 26(3):599-604.

Walter-Echols, G., and E.P. Lichtenstein.
1978b. Effects of lake bottom mud on the movement and metabolism of ^{14}C-phorate in a flooded soil-plant system. J. Environ. Hlth., 13B(3):149-168.

Wang, C.-H.
1972. The effect of soil properties on losses of two chloronitrobenzene fungicides from soils. Dissert. Abstr., 33B(3): 982-983.

Ward, C.T., and F. Matsumura.
1978. Fate of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) in a model aquatic environment. Arch. Environ. Contam. Toxicol., 7:349-357.

Wargo, J.P., R.C. Honeycutt, and I.L. Adler.
1975. Characterization of bound residues of nitrofen in cereal grains. J. Agric. Food Chem., 23(6):1095-1097.

Waring, R.H., and M.S. Wolfe.
1975. Distribution of tridemorph and its metabolites in barley plants grown to maturity. Pestic. Sci., 6:169-172.

Warlen, S.M., D.A. Wolfe, C.W. Lewis, and D.R. Colby.
1977. Accumulation and retention of dietary ^{14}C-DDT by Atlantic menhaden. Trans. Amer. Fish. Soc., 106(1):95-104.

Warrander, A., and R.H. Waring.
1977. The metabolism of mebenil in rats, rabbits and guinea-pigs. Pestic. Sci., 8:54-58.

Wathana, S.
1971. Absorption, translocation, and metabolism of 4-(2,4-dichlorophenoxy)butyric acid in soybean and cocklebur. Dissert. Abstr., 31B(12)(Part 1):7029.

Watkins, D.A.M.
1974. Photolysis of methyl benzimidazol-2-ylcarbamate. Chemosphere, 3(5):239-240.

Watkins, D.A.M.
1976. Photolysis of thiabendazole. Chemosphere, 5(2):77-78.

Watts, R.R., R.W. Storherr, and J.H. Onley.
1974. Effects of cooking on ethylenebisdithiocarbamate degradation to ethylene thiourea. Bull. Environ. Contam. Toxicol., 12(2): 224-226.

Weaver, R.J., H.A. Abdel-Gawad, and G.C. Martin.
1972. Translocation and persistence of 1,2-^{14}C-(2-chloroehtyl)-phosphonic acid (ethephon) in Thompson seedless grapes. Physiol. Plant., 26:13-16.

Weber, K.
1976. Degradation of parathion in seawater. Water Res., 10: 237-241.

Webster, G.R.B., and G.J. Reimer.
1976a. Field degradation of the herbicide metribuzin and its degradation products in a Manitoba sandy loam soil. Weed Res., 16:191-196.

Webster, G.R.B., and G.J. Reimer.
1976b. Cold storage degradation of the herbicide metribuzin in field soil samples awaiting analysis. Pestic. Sci., 7:292-300.

Webster, G.R.B., L.P. Sarna, and S.R. MacDonald.
1978. Nonbiological degradation of the herbicide metribuzin in Manitoba soils. Bull. Environ. Contam. Toxicol., 20:401-408.

Wedig, J.H., C. Mitoma, R.A. Howd, and D.W. Thomas.
1978. Identification of metabolites from salts of pyridine-2-thiol-1-oxide following intravenous and dermal administration swine. Toxicol. Appl. Pharmacol., 43:373-379.

Weinberger, P.R. Greenhalgh, R.P. Moody, and B. Boulton.
1978. The fate of fenitrothion in model aquatic ecosystems. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-524.

Weinheimer, G., and F. Romer.
1977. Der metabolismus von ^{3}H-α-ecdyson bei larven von *Tenebrio molitor*. J. Insect Physiol., 23:619-624.

Wendel, L.E.
1977. Distribution and metabolism of two insect juvenile hormone analogs in colonies of the imported fire ant, *Solenopsis invicta*. Dissert. Abstr., 38B(4):1547.

Wendel, L.E., and S.B. Vinson.
1978. Distribution and metabolism of a juvenile hormone analogue within colonies of the red imported fire ant. J. Econ. Entomol., 71(4):561-565.

Wennerberg, R., and G. Lofroth.
1974. Formation of 7-methylguanine by dichlorvos in bacteria and mice. Chem.-Biol. Interact., 8:339-348.

West, H.D.
1940. Evidence for the detoxication of diphenyl through a sulfur mechanism. Proc. Soc. Exptl. Biol. Med., 43:373-375.

West, H.D., J.R. Lawson, I.H. Miller, and G.R. Mathura.
1955. Fate of diphenyl in the rat. Fed. Proc., 14:303-304.

West, H.D., G.R. Mathura, E.A. Jones, L.K. Akers, and J.R. Lawson.
1953. Metabolism of Diphenyl. Fed. Proc., 12:288-289.

Westlake, W.E., J.R. O'Neal, F.A. Gunther, and G.E. Carman.
1972. Persistence of the insecticide/acaricide phosalone on and in oranges and in laboratory-processed citrus pulp cattle feed. J. Agric. Food Chem., 20(1):161-162.

Westmascott, D., and S.J.L. Wright.
1975. Studies on the breakdown of *p*-chlorophenyl methylcarbamate II. In cultures of a soil *Arthrobacter* sp. Pestic. Sci., 6:61-68.

Wheeler, W.B., N.P. Thompson, and D.H. Forbes.
1978. Formation and characteristics of bound carbofuran residues in radish roots. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-27.

Whitacre, D.M., M. Badie, B.A. Schwemmer, and L.I. Diaz.
1976. Metabolism of ^{14}C-leptophos and ^{14}C-4-bromo-2,5-dichlorophenol in rats: A multiple dosing study. Bull. Environ. Contam. Toxicol., 16(6):689-696.

White, A.F.
1972. Metabolism of the juvenile hormone analogue methyl-farnesoate 10,11-epoxide in two insect species. Life Sci., 11(Part II):201-210.

Whitehouse, L.W., and D.J. Ecobichon.
1975. Paraoxon formation and hydrolysis by mammalian liver. Pestic. Biochem. Physiol., 5:314-322.

Whiteoak, R.J., M. Crofts, and R.J. Harris.
1973. Gas chromatographic method for the residue analysis of soil exposed to fenazaflor. Pestic. Sci., 4:319-325.

Whitten, C.J., and D.L. Bull.
1974. Comparative toxicity, absorption, and metabolism of chlorpyrifos and its dimethyl homologue in methyl parathion-resistant and -susceptible tobacco budworms. Pestic. Biochem. Physiol., 4:266-274.

Whitten, C.J., and D.L. Bull.
1978. Metabolism and absorption of methyl parathion by tobacco budworms resistant or susceptible to organophosphorus insecticides. Pestic. Biochem. Physiol., 9:196-202.

Wichman, J.R.
1973. Uptake, distribution, and degradation of simazine by black walnut and yellow poplar seedlings. Dissert. Abstr., 34B(1):13-14.

Wiebkin, P., J.R. Fry, C.A. Jones, R. Lowing, and J.W. Bridges.
1976. The metabolism of biphenyl by isolated viable rat hepatocytes. Xenobiotica, 6(12):725-743.

Wiebkin, P., J.R. Fry, C.A. Jones, R.K. Lowing, and J.W. Bridges.
1978. Biphenyl metabolism in isolated rat hepatocytes: Effect of induction and nature of the conjugates. Biochem. Pharmacol., 27:1899-1907.

Wiedmann, J.L., G.G. Ecke, and G.G. Still.
1976. Synthesis and isolation of 1-hydroxy-2-propyl 3-chlorocarbanilate from soybean plants treated with isopropyl 3-chlorocarbanilate. J. Agric. Food Chem., 24(3):588-592.

Wieneke, J., and W. Steffens.
1974. Degradation of ^{14}C-azinphos on glass plates as compared to the metabolism on bean leaves. Environ. Qual. Safety, 3(Suppl.):544-548.

Wiener, M., K.A. Pittman, and V. Stein.
1976. Mirex kinetics in the rhesus monkey. I. Disposition and excretion. Drug Metab. Dispos., 4(3):281-287.

Wigren, N.I.
1924. Ueber einige verbindungen der diathylarsinreike. Justus Liebig's Ann. Chem., 437:285-296.

Willemot, C., and L. Belzile.
1970. Incorporation de la radioactivite du chlorure de (2-chloroethyl)trimethylammonium-1,2-^{14}C dans la phosphatidylcholine de folioles de luzerne. Can. J. Biochem., 48:994-998.

Williams, I.H.
1975. Persistence of chlorfenvinphos in soils. Pestic. Sci., 6:501-509.

Williams, I.H., H.S. Pepin, and M.J. Brown.
1976. Degradation of carbofuran by soil microorganisms. Bull. Environ. Contam. Toxicol., 15(2):244-249.

Williams, R.R., and T.F. Bidleman.
1978. Toxaphene degradation in estuarine sediments. J. Agric. Food Chem., 26(1):280-282.

Willis, D.E., and R.F. Addison.
1974. Hydroxylation of biphenyl in vitro by tissue preparations of some marine organisms. Comp. Gen. Pharmac., 5:77-81.

Wilson, R.G., Jr., and H.H. Cheng.
1978. Fate of 2,4-D in a Naff silt loam soil. J. Environ. Qual., 7(2):281-286.

Wilson, T.G., and L.I. Gilbert.
1978. Metabolism of juvenile hormone I in *Drosophila melanogaster*. Comp. Biochem. Physiol., 60A:85-89.

Windom, H., W. Gardner, J. Stephens, and F. Taylor.
1976. The role of methylmercury production in the transfer of mercury in a salt marsh ecosystem. Estuarine Coastal Mar. Sci., 4:579-583.

Wiseman, A., J.A. Gondal, and P. Sims.
1975. 4'-Hydroxylation of biphenyl by yeast containing cytochrome P-450: Radiation and thermal stability, comparisons with liver enzyme (oxidized and reduced forms). Biochem. Soc. Transact., 3:278-281.

Witkonton, F.
1974. Fate of the pesticide *N*'-(4-chloro-*o*-tolyl)-*N*,*N*-dimethylformamidine in fruit and soil, and toxicological properties of some of its conversion products. Dissert. Abstr., 34B(8):3831.

Wolf, D.C., and J.P. Martin.
1976. Decomposition of fungal mycelia and humic-type polymers containing carbon-^{14} from ring and side-chain labeled 2,4-D and chlorpropham. Soil Sci. Soc. Amer. J., 40(5):700-704.

Wolfe, N.L., R.G. Zepp, G.L. Baughman, and J.A. Gordon.
1974. Kinetic investigation of malathion degradation in water. Abstr. 167th ACS Meeting, Los Angeles, CA, PEST 65.

Wolfe, N.L., R.G. Zepp, J.C. Doster, and R.C. Hollis.
1976a. Captan hydrolysis. J. Agric. Food Chem., 24(5):1041-1045.

Wolfe, N.L., R.G. Zepp, J.A. Gordon, G.L. Baughman, and D. Cline.
1977a. Kinetics of chemical degradation of malathion in water. Environ. Sci. Technol., 11(1):88-93.

Wolfe, N.L., R.G. Zepp, J.A. Gordon, and R.C. Fincher.
1976b. *N*-nitrosamine formation from atrazine. Bull. Environ. Contam. Toxicol., 15(3):342-347.

Wolfe, N.L., R.G. Zepp, and D.F. Paris.
1978. Carbaryl, propham and chlorpropam: A comparison of the rates of hydrolysis and photolysis with the rate of biolysis. Water Res., 12:565-571.

Wolfe, N.L., R.G. Zepp, D.F Paris, G.L. Baughman, and R.C. Hollis.
1976c. Methoxychlor and DDT degradation in water: Rates and products. Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 109.

Wolfe, N.L., R.G. Zepp, D.F. Paris, G.L. Baughman, and R.C. Hollis.
1977b. Methoxychlor and DDT degradation in water: Rates and products. Environ. Sci. Technol., 11(12):1077-1081.

Wong, A.S., and D.G. Crosby.
1976. Photodecomposition of pentachlorophenol (PCP). Abstr. 172nd ACS Meeting, San Francisco, CA, PEST 96.

Wood, P.A., and I.C. MacRae.
1977. Reduction of fensulfothion to fensulfothion sulfide by *Klebsiella pneumoniae*. Appl. Environ. Microbiol., 34(3):247-250.

Woodrow, J.E., D.G. Crosby, T. Mast, K.W. Moilanen, and J.N. Seiber.
1978. Rates of transformation of trifluralin and parathion vapors in air. J. Agric. Food Chem., 26(6):1312-1316.

Woodrow, J.E., J.N. Seiber, D.G. Crosby, K.W. Moilanen, C.J. Soderquist, and C. Mourer.
1977. Airborne and surface residues of parathion and its conversion products in a treated plum orchard environment. Arch. Environ. Contam. Toxicol., 6:175-191.

Woolson, E.A.
1974. The persistence and chemical distribution of arsanilic acid in three soils. Abstr. 167th ACS Meeting, Los Angeles, CA, PEST 58.

Woolson, E.A.
1975. The persistence and chemical distribution of arsanilic acid in three soils. J. Agric. Food Chem., 23(4):677-681.

Woolson, E.A.
1976. Generation of dimethyl arsine from soil. Abstr. Weed Sci. Soc. Amer., 91.

Woolson, E.A.
1977a. Fate of arsenicals in different environmental substrates. Environ. Hlth. Perspec., 19:73-81.

Woolson, E.A.
1977b. Generation of alkylarsines from soil. Weed Sci., 25(5): 412-416.

Woolson, E.A., A.R. Isensee, and P.C. Kearney.
1976. Distribution and isolation of radioactivity from ^{74}As-arsenate and ^{14}C-methanearsonic acid in an aquatic model ecosystem. Pestic. Biochem. Physiol., 6:261-269.

Woolson, E.A., and P.C. Kearney.
1973. Persistence and reactions of ^{14}C-cacodylic acid in soils. Environ. Sci. Tech., 7(1):47-50.

Wright, S.J.L., A.F. Stainthorpe, and J.D. Downs.
1977. Interactions of the herbicide propanil and a metabolite, 3,4-dichloroaniline, with blue-green algae. Acta Phytopathol. Acad. Sci. Hung., 12(1-2):51-60.

Wyndham, C., J. Devenish, and S. Safe.
1976. The *in vitro* metabolism, macromolecular binding and bacterial mutagenicity of 4-chlorobiphenyl, a model PCB substrate. Res. Commun. Chem. Pathol. Pharm., 15(3):563-570.

Wyndham, C., and S. Safe.
1978. A comparison of the in vitro metabolism of biphenyl and 4-chlorobiphenyl by rat liver microsomes. Can. J. Biochem., 56(10):993-997.

Wyrill, J.B., III, and O.C. Burnside.
1976. Absorption, translocation, and metabolism of 2,4-D and glyphosate in common milkweed and hemp dogbane. Weed Sci., 24(6): 557-566.

Yacobi, A., L.B. Wingard, Jr., and G. Levy.
1974. Comparative pharmacokinetics of coumarin anticoagulants X: Relationship between distribution, elimination, and anticoagulant action of warfarin. J. Pharmaceu. Sci., 63(6):868-872.

Yadav, D.V., H.C. Agarwal, and M.K.K. Pillai.
1978. Uptake, metabolism and excretion of DDT by the fresh water snail, *Vivipara heliciformis*. Bull. Environ. Contam. Toxicol., 19:300-306.

Yaklich, R.W., S.J. Karczmarczyk, and R.M. Devlin.
1974. Metabolism of ^{14}C-SAN-6706 and ^{14}C-Norflurazon in cranberry plants. Weed Sci., 22(6):595-599.

Yamaguchi, M., C.W. Chu, and S.F. Yang.
1971. The fate of ^{14}C(2-chloroethyl)phosphonic acid in summer squash, cucumber, and tomato. J. Amer. Soc. Hort. Sci., 96(5): 606-609.

Yamamoto, I., S. Maki, and K. Sato.
1978. Metabolism of an aryl *N*-propylcarbamate *in vitro* by a rat liver enzyme system. J. Pestic. Sci., 3(1):53-54.

Yamamoto, H.-A., H. Yoshimura, M. Fujita, and T. Yamamoto.
1976. Metabolic and toxicologic evaluation of 2,3,4,3',4'-pentachlorobiphenyl in rats and mice. Chem. Pharm. Bull., 24(9): 2168-2174.

Yang, R.S.H., and K.A. Pittman.
1975. Fate of [^{14}C]hexachlorobenzene in the Rhesus monkey and the rat. Toxicol. Appl. Pharmacol., 33:147.

Yang, R.S.H., K.A. Pittman, D.R. Rourke, and V.B. Stein.
1978. Pharmacokinetics and metabolism of hexachlorobenzene in the rat and the Rhesus monkey. J. Agric. Food Chem., 26(5):1076-1083.

Yaron, B.
1975. Chemical conversion of parathion on soil surfaces. Soil Sci. Soc. Amer. Proc., 39:639-643.

Yasuda, Y., S. Hashimoto, Y. Soeda, and T. Noguchi.
1973. Metabolism of thiophanate-methyl by pathogenic fungi and antifungal activity of its metabolites. Ann. Phytopath. Soc. Japan, 39:49-52.

Yi, J.M., C.T. Sprouse, E.R. Bowman, and H. McKennis, Jr.
1977. The interrelationship between the metabolism of (*S*)-cotinine-*N*-oxide and (*S*)-cotinine. Drug Metab. Dispos., 5(4):355-362.

Yonaha, M., S. Ishikura, and M. Uchiyama.
1975. Toxicity of organic mercury compounds. IV. Metabolism and excretion of alkoxyethylmercury compounds in mice. Chem. Pharm. Bull., 23(8):1726-1732.

Yoshida, T., and T.F. Castro.
1975. Degradation of 2,4-D, 2,4,5-T, and picloram in two Philippine soils. Soil Sci. Plant. Nutr., 21(4):397-404.

Yoshihara, S., and R.A. Neal.
1977. Comparison of the metabolism of parathion by a rat liver reconstituted mixed-function oxidase enzyme system and by a system containing cumene hydroperoxide and purified rat liver cytochrome P-450. Drug Metab. Dispos., 5(2):191-197.

Young, R.H., and O.L. Jahn.
1975. The fate of 1,2-^{14}C-(2-chloroethyl)phosphonic acid in citrus. J. Amer. Soc. Hort. Sci., 100(5):496-499.

Yu, C.-C., G.M. Booth, D.J. Hansen, and J.R. Larsen.
1974a. Fate of bux insecticide in a model ecosystem. Environ. Entomol., 3(6):975-977.

Yu, C.-C., G.M. Booth, D.J. Hansen, and J.R. Larsen.
1974b. Fate of carbofuran in a model ecosystem. J. Agric. Food Chem., 22(3):431-434.

Yu, C.-C., G.M. Booth, D.J. Hansen, and J.R. Larsen.
1975a. Fate of pyrazon in a model ecosystem. J. Agric. Food Chem., 23(2):309-311.

Yu, C.-C., G.M. Booth, D.J. Hansen, and J.R. Larsen.
1975b. Fate of alachlor and propachlor in a model ecosystem. J. Agric. Food Chem., 23(5):877-879.

Yu, C.-C., D.J. Hansen, and G.M. Booth.
1975c. Fate of dicamba in a model ecosystem. Bull. Environ. Contam. Toxicol., 13(3):280-283.

Yu, C.-C., and J.R. Sanborn.
1975. The fate of parathion in a model ecosystem. Bull. Environ. Contam. Toxicol., 13(5):543-550.

Yu, S.J., and L.C. Terriere.
1975. Microsomal metabolism of juvenile hormone analogs in the house fly, *Musca domestica* L. Pestic. Biochem. Physiol., 5:418-430.

Yu, S.J., and L.C. Terriere.
1977a. Metabolism of [^{14}C]hydroprene (ethyl 3,7,11-trimethyl-2,4-dodecadienoate) by microsomal oxidases and esterases from three species of diptera. J. Agric. Food Chem., 25(5):1076-1080.

Yu, S.J., and L.C. Terriere.
1977b. Ecdysone metabolism by soluble enzymes from three species of diptera and its inhibition by the insect growth regulator TH-6040. Pestic. Biochem. Physiol., 7:48-55.

Yu, S.J., and L.C. Terriere.
1977c. Esterase and oxidase activity of house fly microsomes against juvenile hormone analogues containing branched chain ester groups and its induction by phenobarbital. J. Agric. Food Chem., 25(6):1333-1336.

Yu, S.J., and L.C. Terriere.
1978. Metabolism of juvenile hormone I by microsomal oxidase, esterase, and epoxide hydrase of Musca domestica and some comparisons with Phormia regina and Sarcophaga bullata. Pestic. Biochem. Physiol., 9:237-246.

Zaki, M.A., H.F. Taylor, and R.L. Wain.
1967. Studies with 3,5-diiodo-4-hydroxybenzonitrile (ioxynil) and related compounds in soils and plants. Ann. Appl. Biol., 59:481-491.

Zayed, S., I.M.I. Fakhr, and A. Hassan.
1974. Chemistry and toxicology of pesticide chemicals. II. Stability of leptophos. Environ. Qual. Safety, 3(Suppl.): 713-717.

Zemskaya, V.A., Y.V. Rakitin, L.M. Chernikova, and Z.V. Kalibernaya.
1976. On the nature of bonds between 2,4-D and proteins in maize leaves. Soviet Plant Physiol. (Fiziolog. Rastenii), 22(5):1044-1046.

Zemskaya, V.A., Y.V. Rakitin, L.M. Chernikova, and Z.V. Kalibernaya.
1977. Distribution and transformation of 2,4-D in tissues of gramineous plants. Fiziologiya Rastenii, 24(6):1234-1241.

Zepp, R.G., N.L. Wolfe, L.V. Azarraga, R.H. Cox, and C.W. Pape.
1977. Photochemical transformation of the DDT and methoxychlor degradation products, DDE and DMDE, by sunlight. Arch. Environ. Contam. Toxicol., 6:305-314.

Zepp, R.G., N.L. Wolfe, G.L. Baughman, and J.A. Gordon.
1974. Chemical and photochemical alteration of 2,4-D esters in the aquatic environment. Environ. Qual. Safety, 3(Suppl.): 313-318.

Zepp, R.G., N.L. Wolfe, J.A. Gordon, and G.L. Baughman.
1975. Dynamics of 2,4-D esters in surface waters. Hydrolysis, photolysis, and vaporization. Environ. Sci. Technol., 9(13): 1144-1150.

Zepp, R.G., N.L. Wolfe, J.A. Gordon, and R.C. Fincher.
1976. Light-induced transformations of methoxychlor in aquatic systems. J. Agric. Food Chem., 24(4):727-733.

Zeyer, J., J. Bodmer, and R. Hutter.
1978a. Microbial degradation of hydroxy-derivatives of s-triazine herbicides. Experientia, 34(12):1671.

Zeyer, J., R. Hutter, and J. Bodmer.
1978b. Microbial degradation of hydroxy-derivatives of s-triazine herbicides. Abstr. 4th Internat. Congr. Pest. Chem. (IUPAC), Zurich, V-634.

Zinck, M.E., and R.F. Addison.
1975. The effect of temperature on the rate of conversion of p,p'-DDT to p,p'-DDE in brook trout (Salvelinus fontinalis). Can. J. Biochem., 53(5):636-639.

Zitko, V., and W.G. Carson.
1977. Uptake and excretion of chlorinated diphenyl ethers and brominated toluenes by fish. Chemosphere, 6(6):293-301.

Zulalian, J., and R.C. Blinn.
1977. Metabolism of cytrolane systemic insecticide (mephosfolan), propylene (diethoxyphosphinyl)dithioimidocarbonate, in cotton plants. J. Agric. Food Chem., 25(5):1033-1039.

Zurqiyah, A.A., L.S. Jordan, and V.A. Jolliffe.
1976. Metabolism of isopropyl carbanilate (propham) in alfalfa grown in nutrient solution. Pestic. Biochem. Physiol., 6:35-45.

Zussman, R.A., E.E. Vicher, and I. Lyon.
1961. Arsine production by Trichophyton rubrum. J. Bacteriol., 81:157.

Zwick, R.W., U. Kiigemagi, and G.J. Fields.
1977. Residues of dimethoate and dimethoxon on sweet cherries following air carrier application. J. Agric. Food Chem., 25(4): 937-940.

Appendix I

Table I

Herbicide persistence in soil

Herbicide	Conc. added (ppm)	$T_{1/2}$(days) Flooded	Upland	Rice Field
Benthiocarb	50	7-100	8-80	
Chlomethoxynil	10	7- 35	50	
CNP	10	7- 35	50	
CNP	6-9			ca. 14
Nitrofen	10	3- 25	50	
Nitrofen	7-8			ca. 14
PCP	100	12-70	18-120	
PCP	ca.10			10-17
SWEP	25	2-9		
SWEP	15-35			10

(Kuwatsuka and Niki, 1976)

Table II

Herbicide persistence

Compound	$T_{1/2}$ (days) Bosket Sandy Loam	Sharkey Clay		
	Greenhouse	Greenhouse	Field cap.	Flooded
Butralin	29	52	36	24
Dinitramine	33	45	31	22
Fluchloralin	29	73	52	8
Pendimethalin			99	37
Profluralin	60	124	44	12
Trifluralin	50	91	48	20

(Savage, 1978)

Appendix II

Table III

Herbicide Photodecomposition

When exposed to unfiltered solar radiation in July, less than 50% of the original compound remained after 7 days with three exceptions.

Compound tested	Percent remaining after 7 days
AC 92390	79
Benefin	15
Butralin	33
Dinitramine	28
Fluchloralin	34
Isopropalin	11
Nitralin	41
Oryzalin	23
Pendimethalin	90
Profluralin	59
Trifluralin	43

(Parochetti and Dec, 1978)

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